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Wetsch et al.

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(54) **APPARATUS FOR CRUMPLING PAPER SUBSTRATES**

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This patent is subject to a terminal disclaimer.

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Related U.S. Application Data

(63) Continuation of application No. 12/824,932, filed on Jun. 28, 2010, now Pat. No. 8,016,735, which is a continuation of application No. 12/008,166, filed on Jan. 29, 8, now Pat. No. 7,771,338, which is a continuation-in-part of application No. 11/811,862, filed on Jun. 12, 2007, now Pat. No. 7,744,519.

(60) Provisional application No. 60/844,565, filed on Sep. 14, 2006, provisional application No. 60/853,585, filed on Oct. 23, 2006, provisional application No. 60/906,761, filed on Mar. 12, 2007.

(51) **Int. Cl.**
B21B 1/00 (2006.01)
B31F 1/20 (2006.01)

(52) **U.S. Cl.** **493/464**; 493/967

(58) **Field of Classification Search** 493/464, 493/967, 352, 459, 461, 462, 435, 434, 442, 493/454, 346; 53/520, 121, 474, 472, 238

See application file for complete search history.

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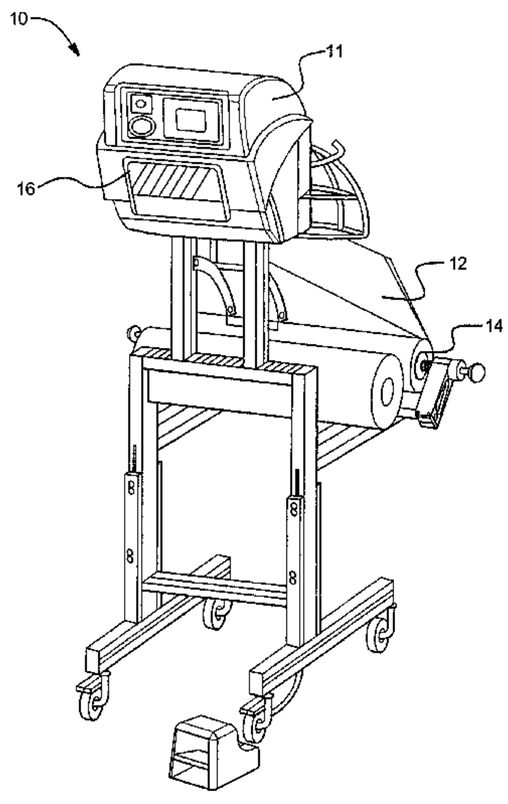
(74) *Attorney, Agent, or Firm* — Dorsey & Whitney LLP

(57) **ABSTRACT**

The present subject matter relates generally to an apparatus for crumpling paper substrates. Specifically, the system provides for the crumpling of paper substrates to form fill material to be utilized in product packaging to fill void space and/or to wrap around products thereby allowing for safe transport of the products. The apparatus includes a feeder for feeding sheeting material, a first roller connected to a drive mechanism, a second roller disposed adjacent said first roller wherein said sheeting material travels between the first roller and the second roller and further wherein the second roller pushes said sheeting material against said first roller to engage the sheeting material with the first roller, and a third roller connected to the drive mechanism for directing said sheeting material out of said apparatus.

14 Claims, 15 Drawing Sheets



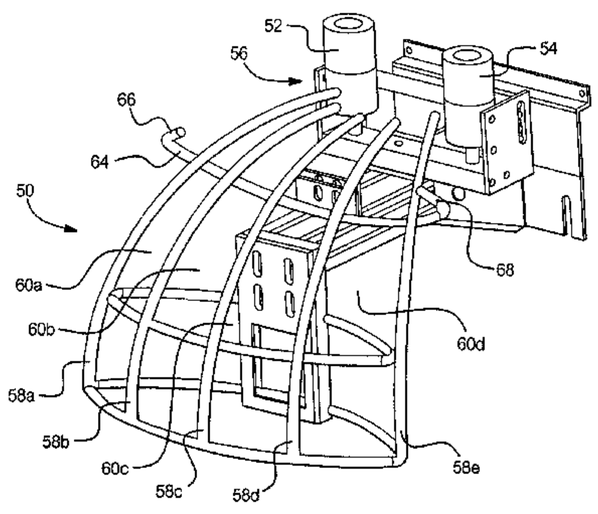


FIG. 1

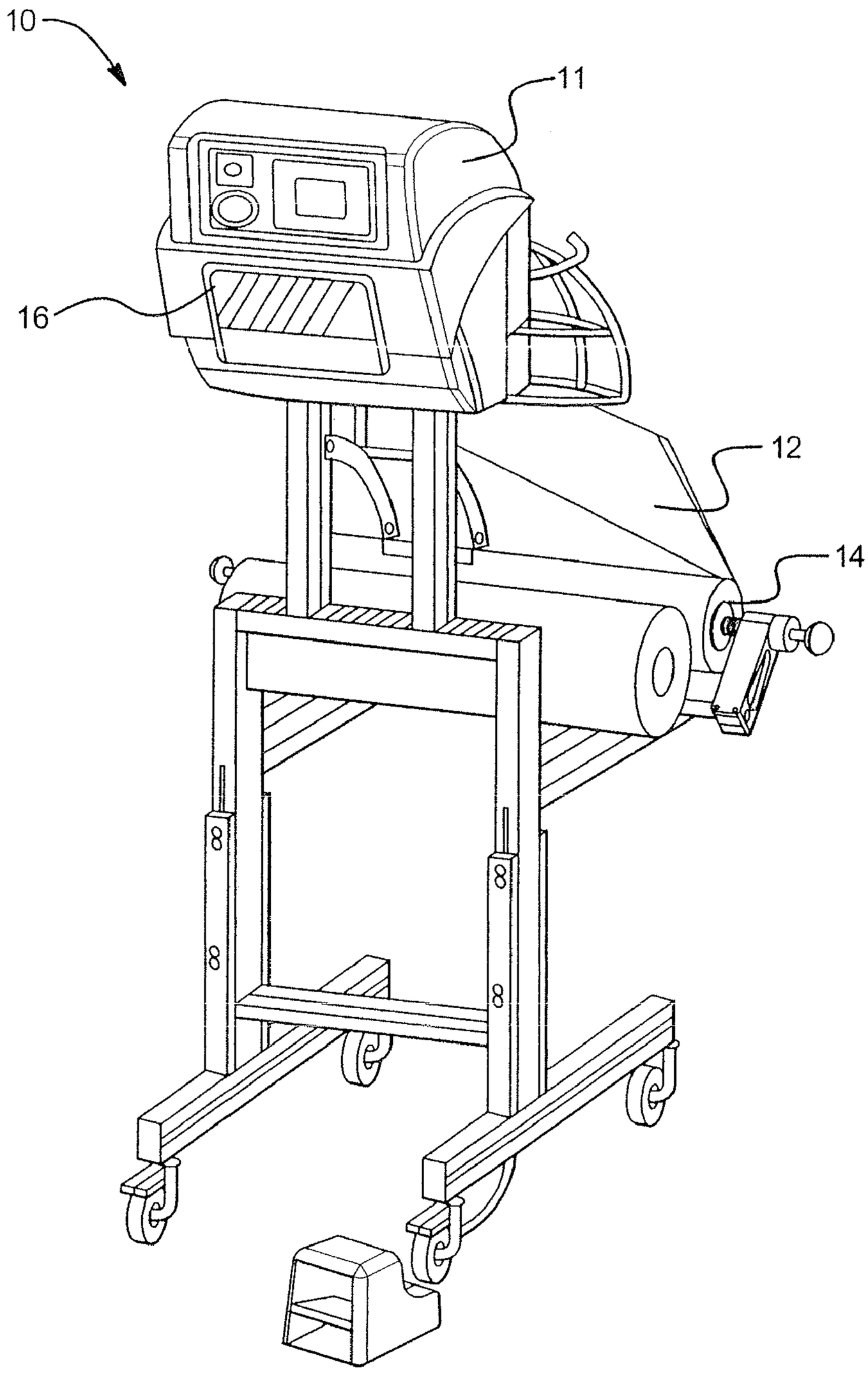


FIG. 2

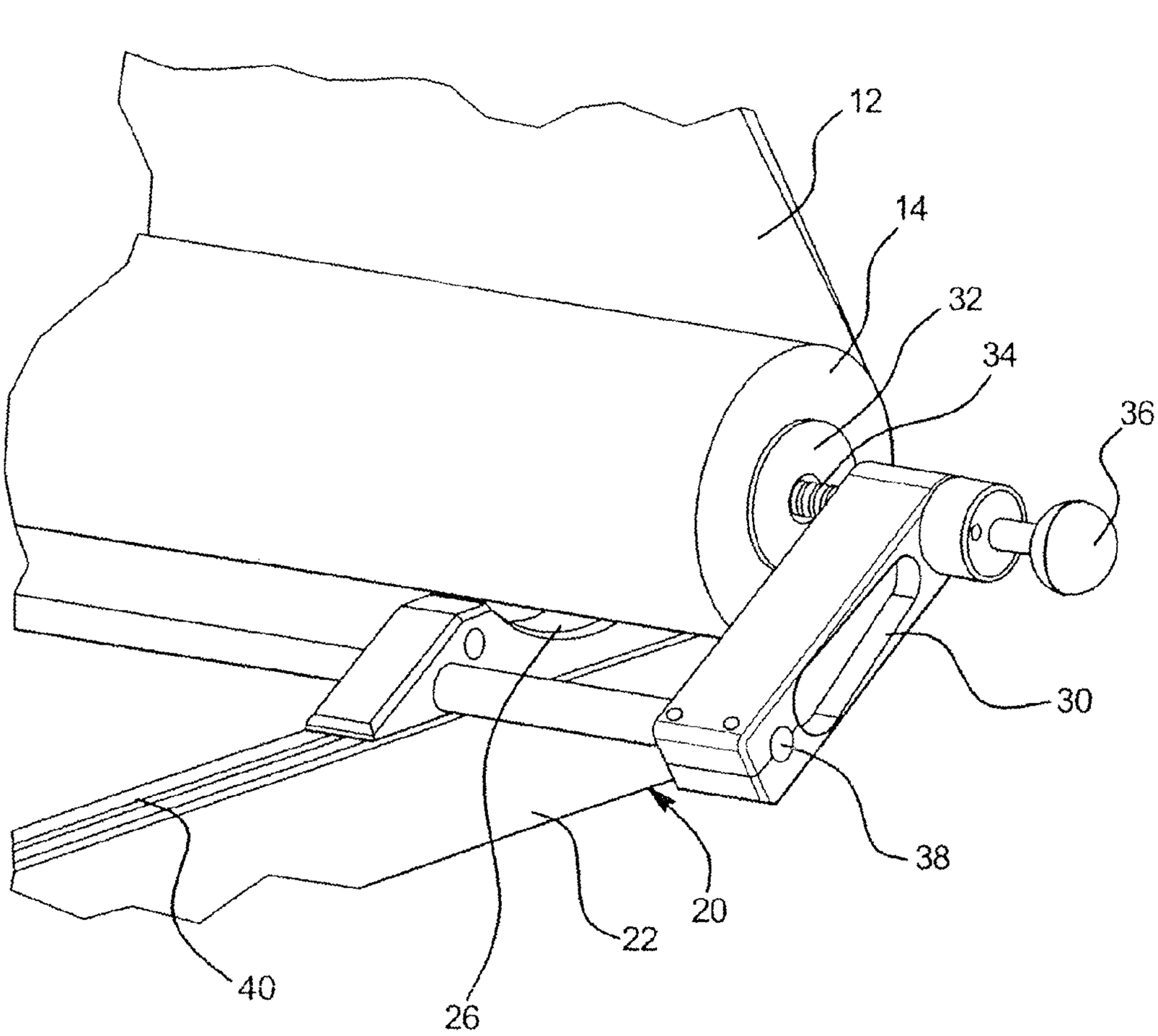


FIG. 3A

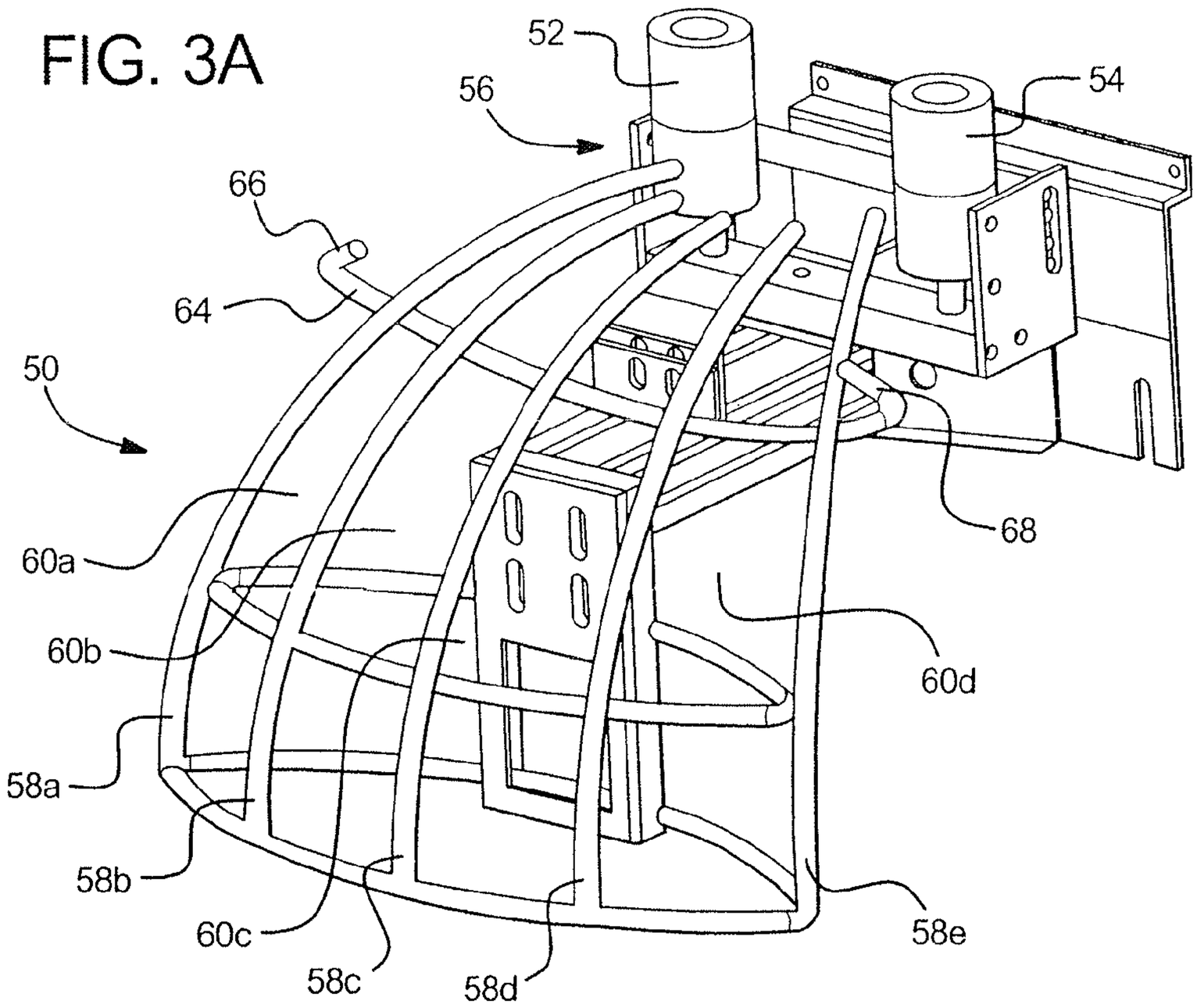

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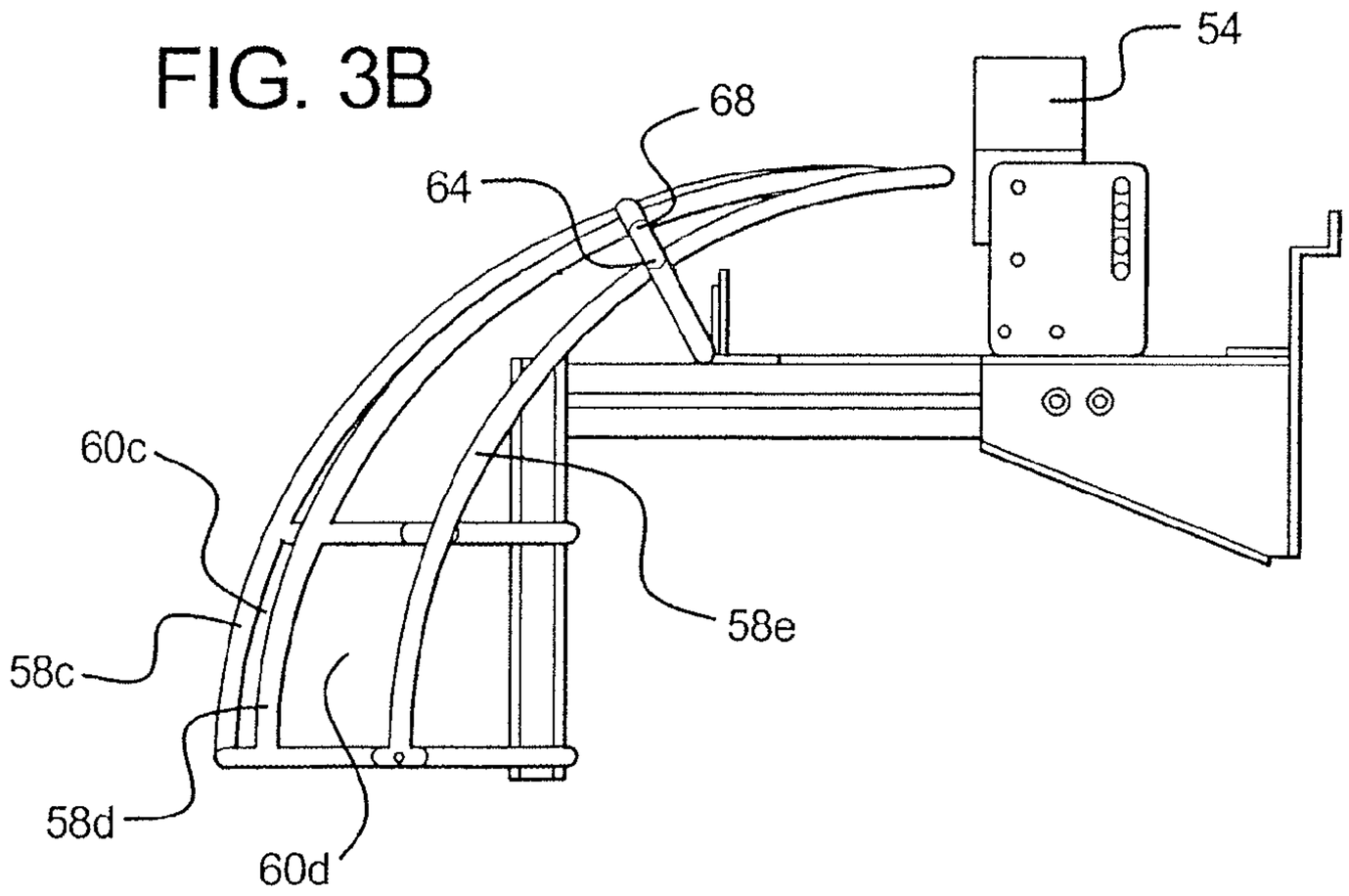
FIG. 3B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58d
60d

FIG. 4A

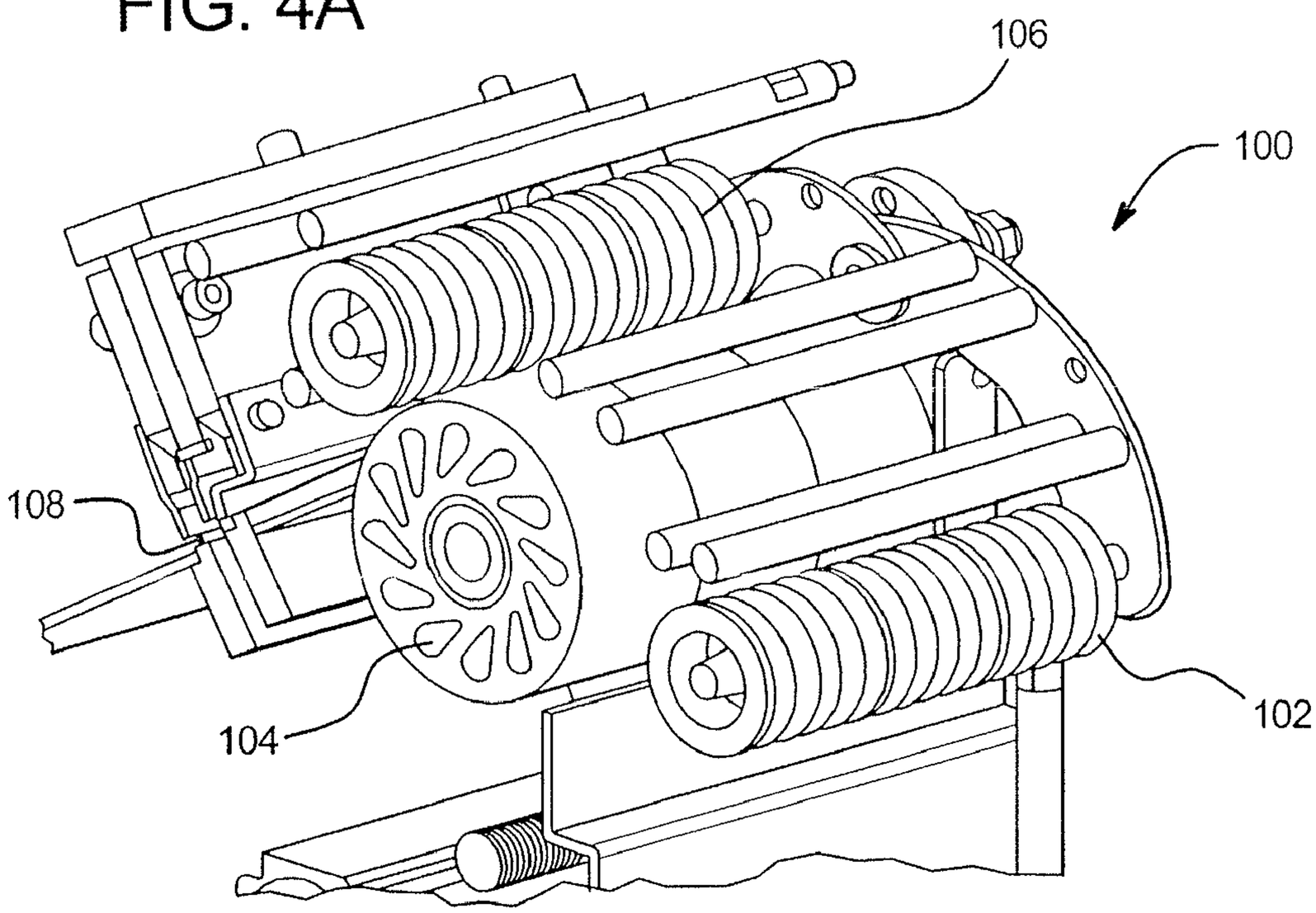
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FIG. 4B

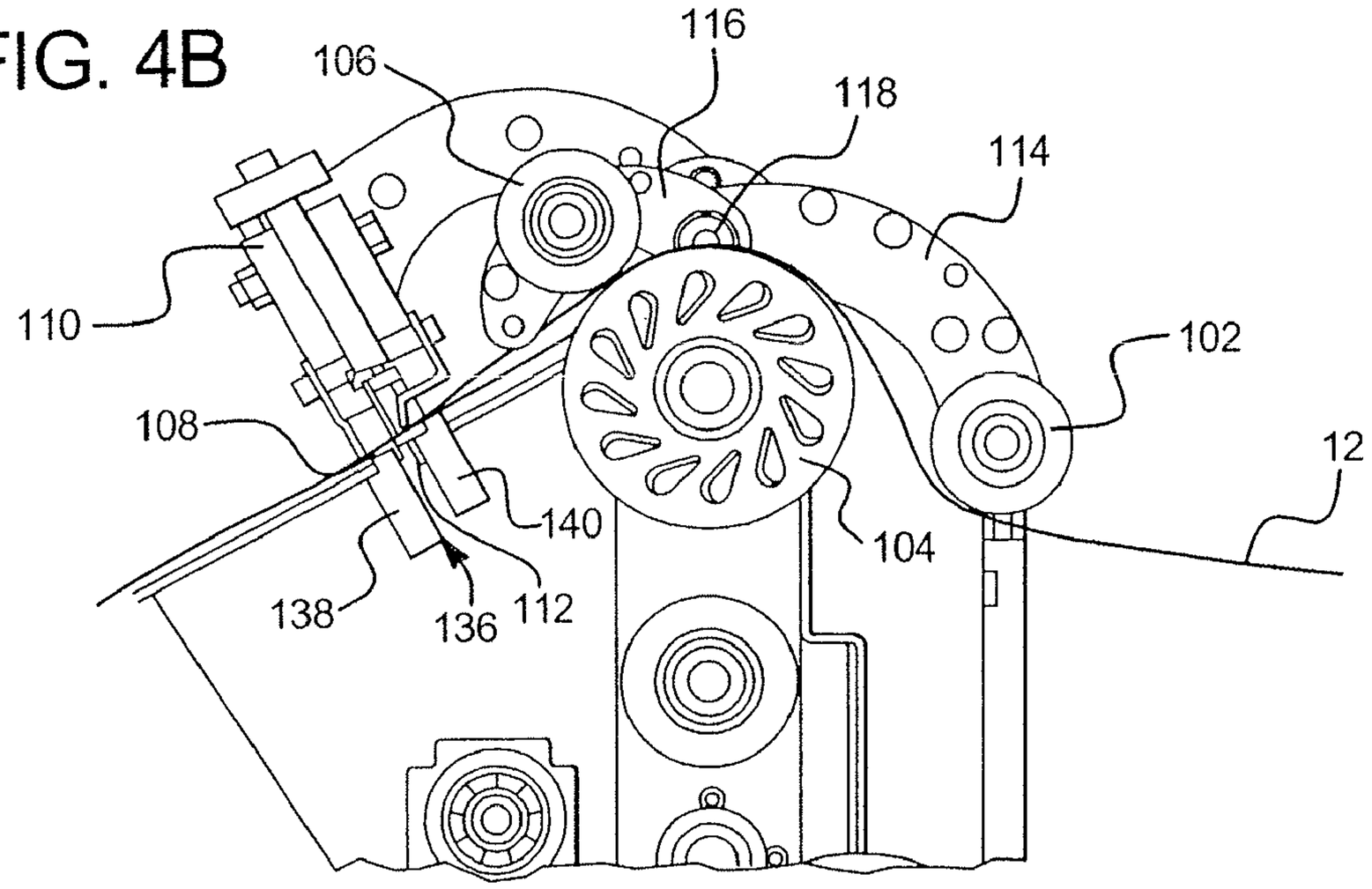
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FIG. 5

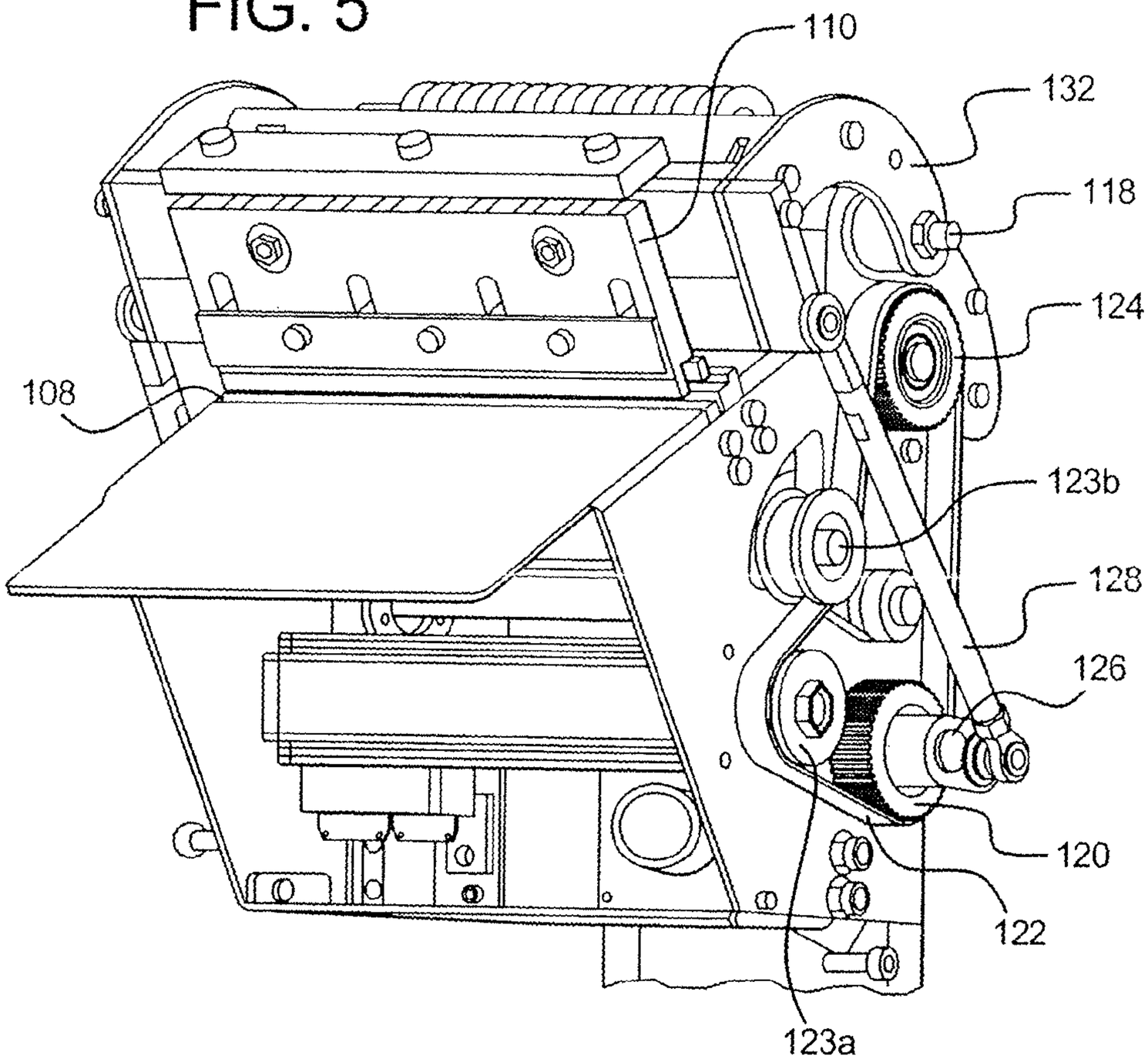
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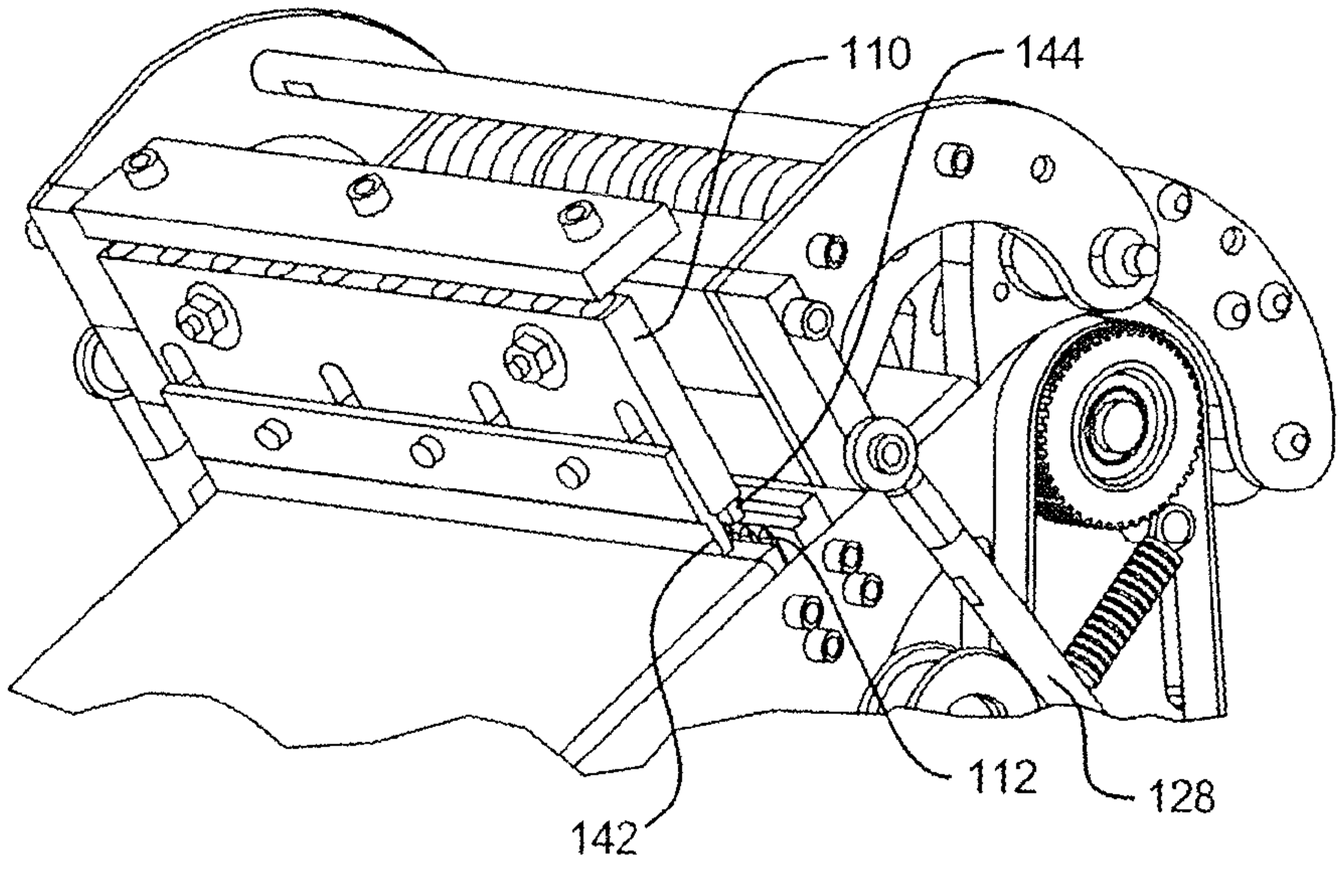
FIG. 6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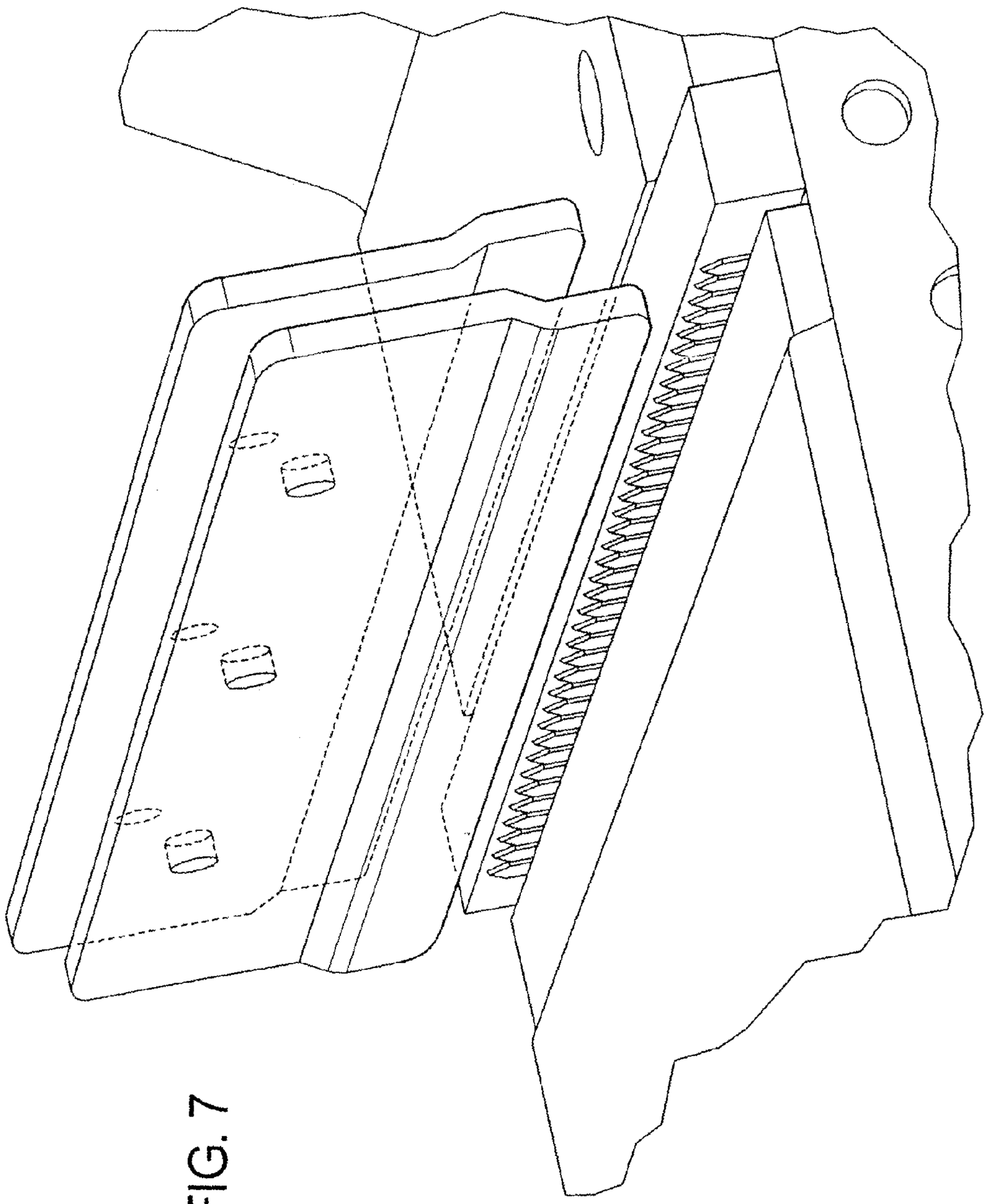
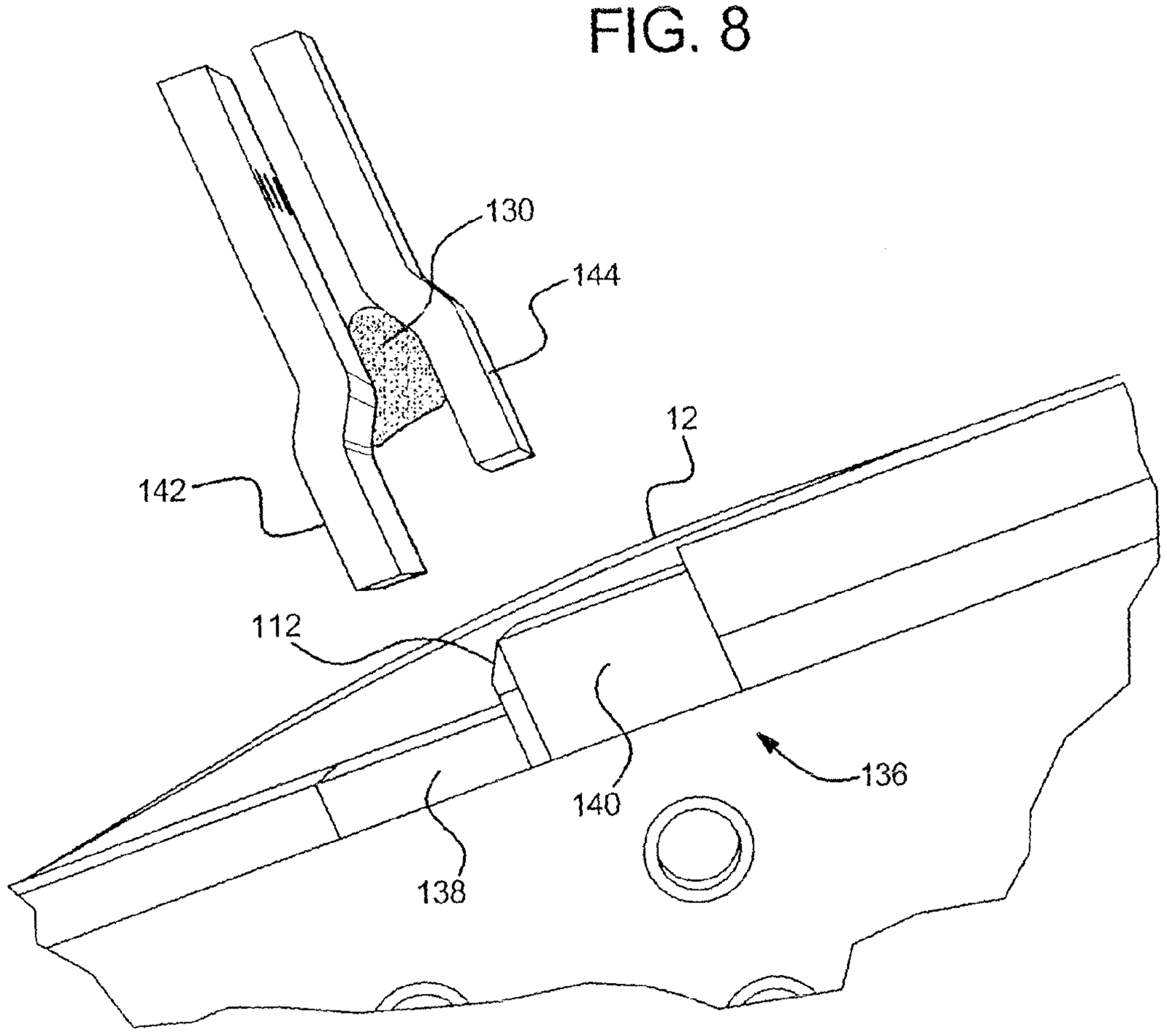


FIG. 7

FIG. 8



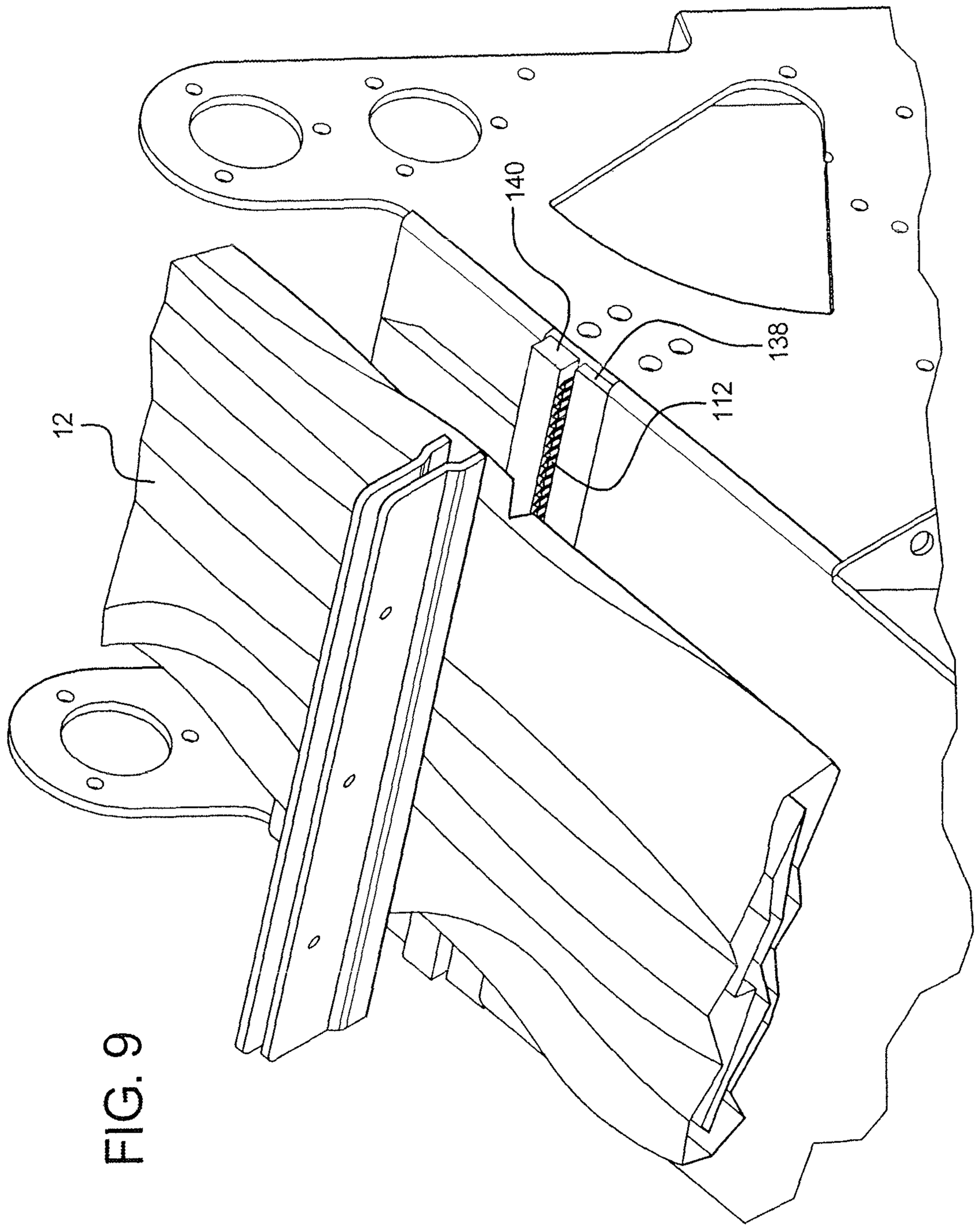
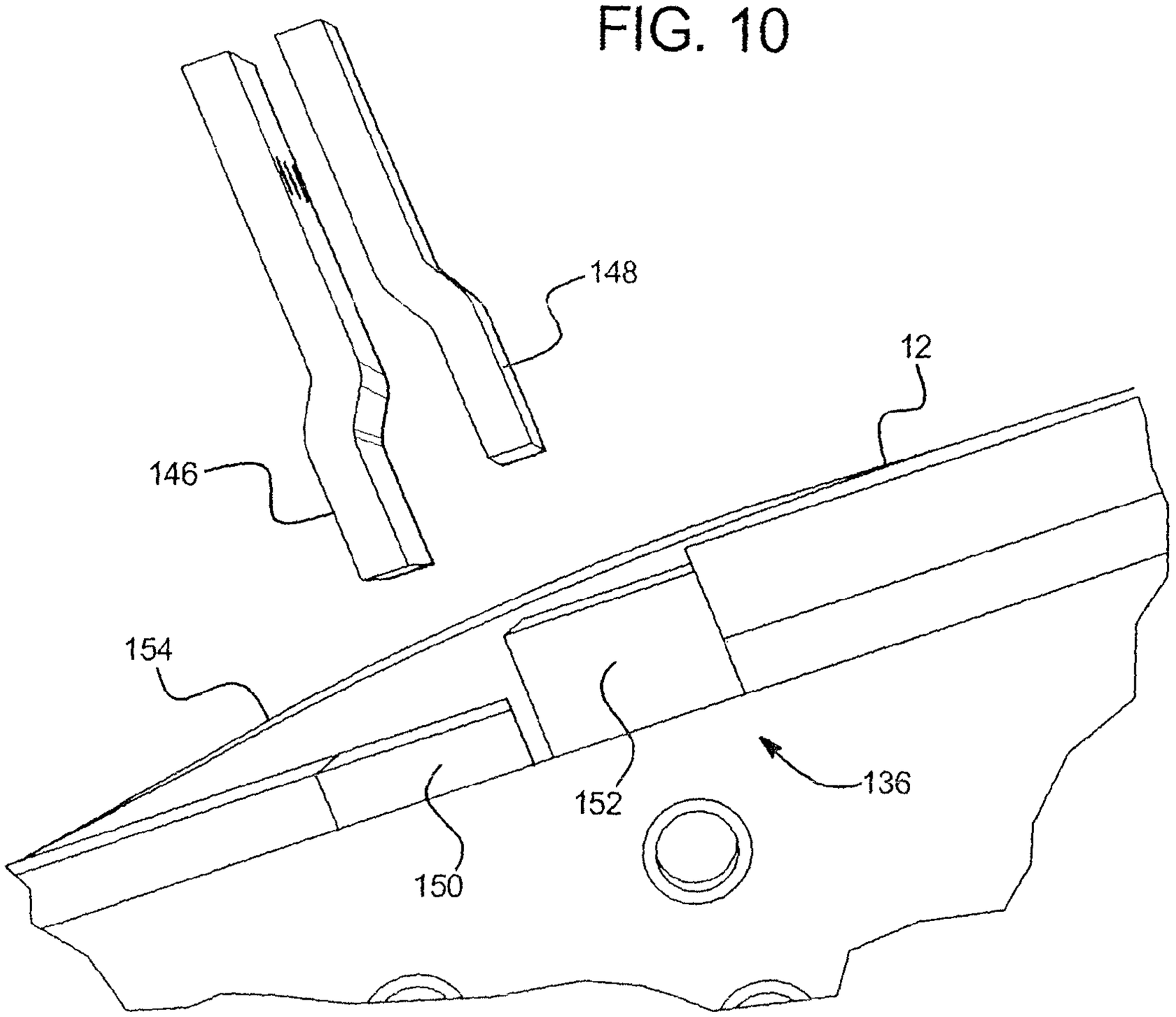


FIG. 9

FIG. 10



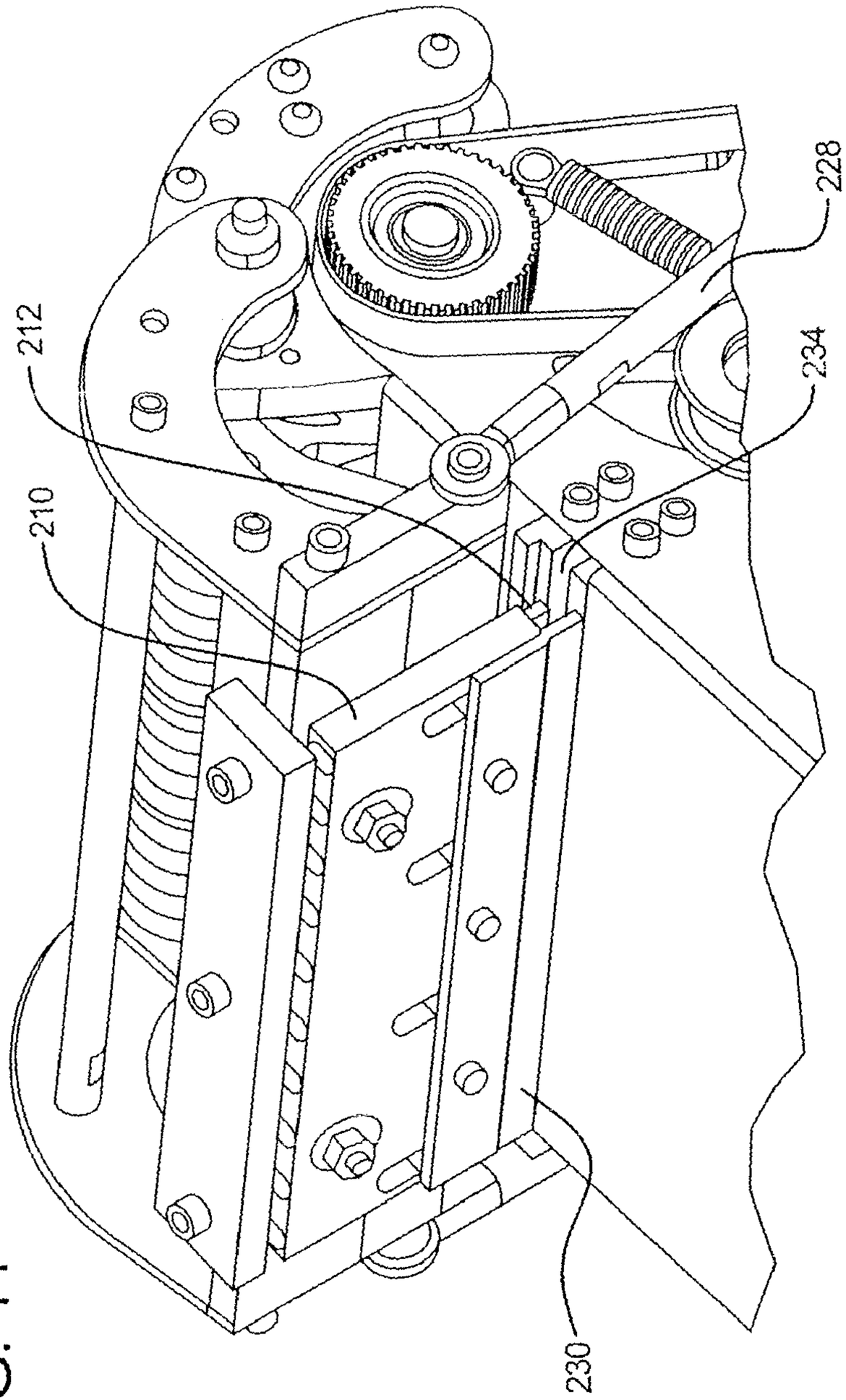
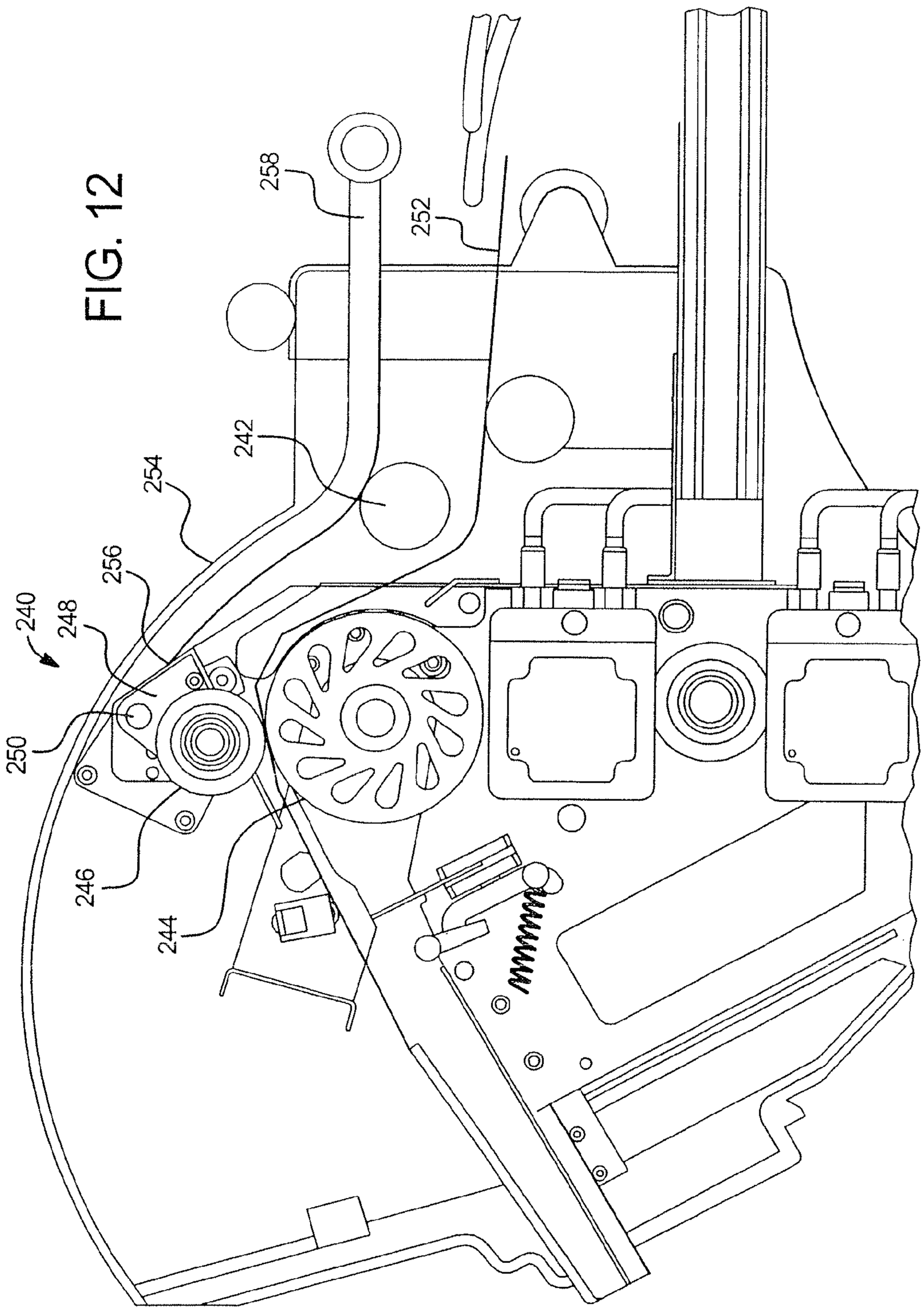


FIG. 11

FIG. 12



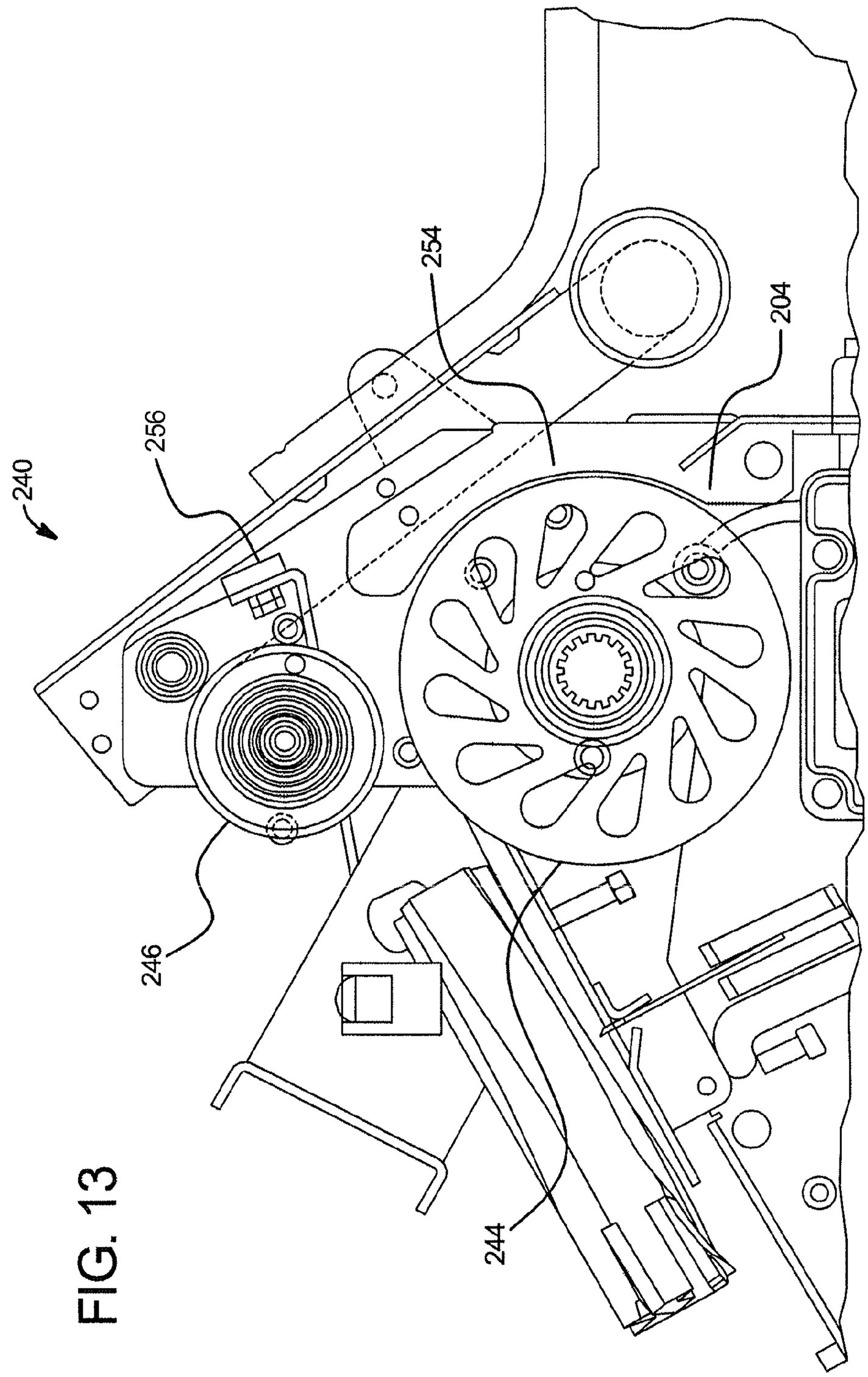


FIG. 13

FIG. 14

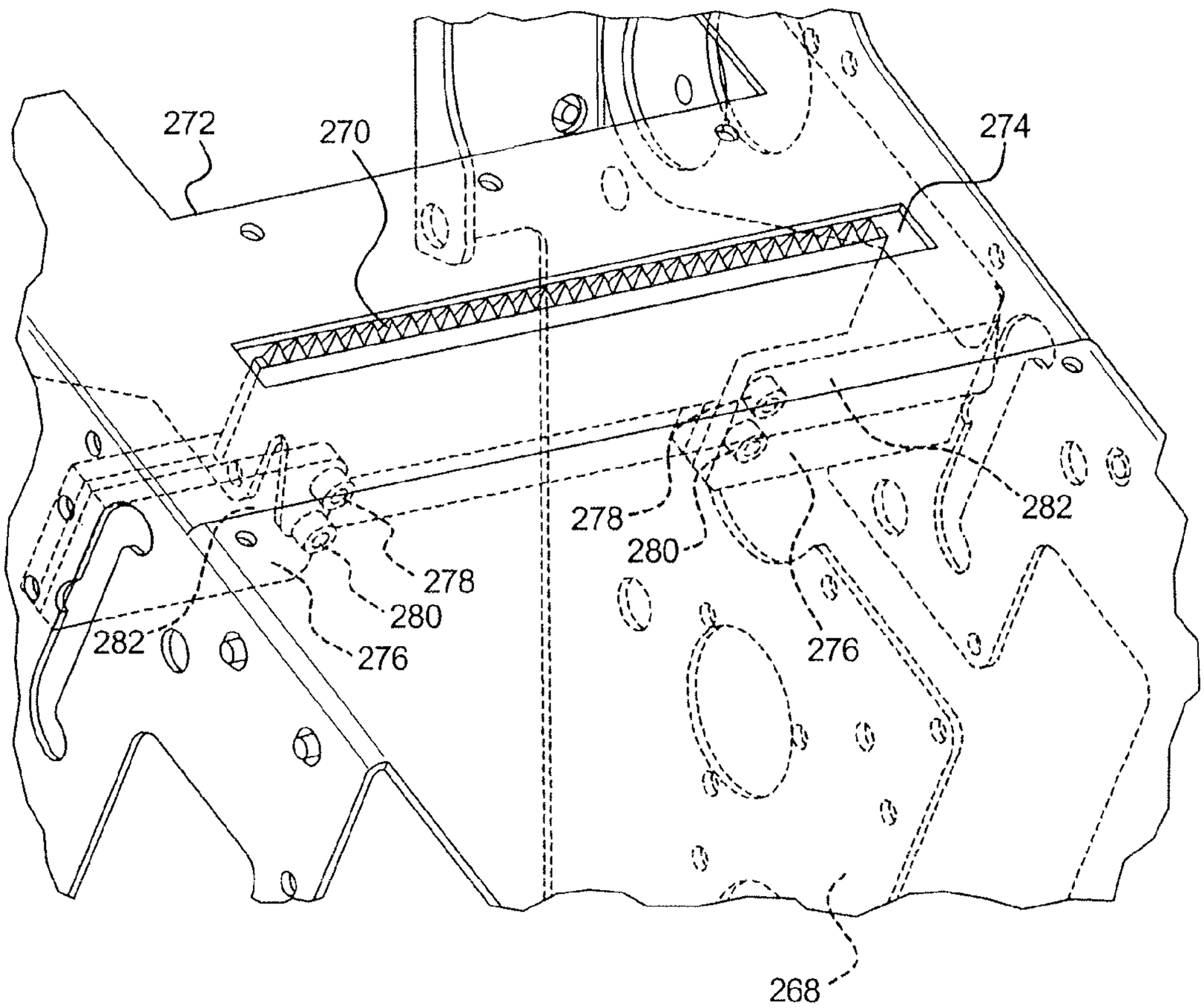
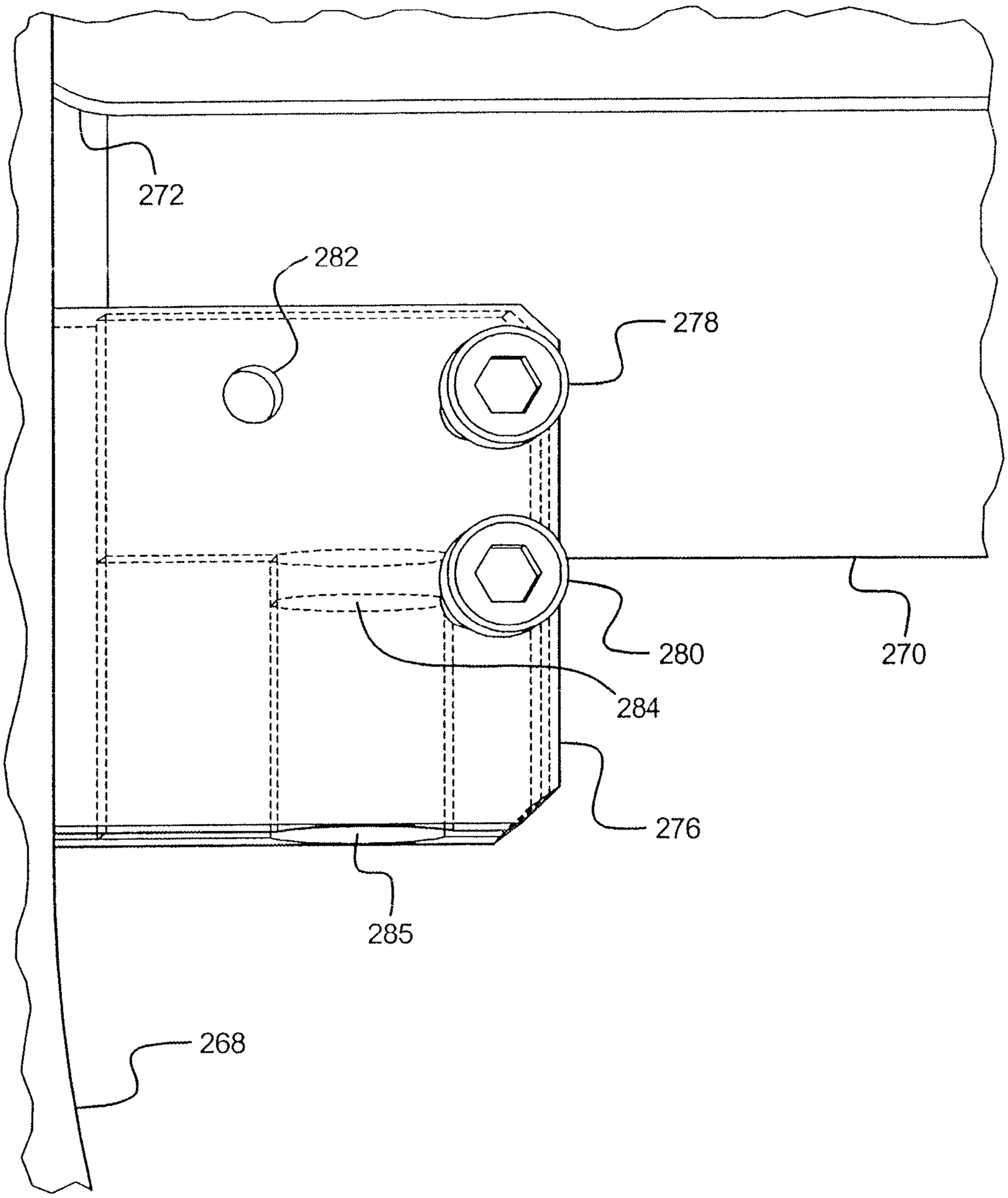


FIG. 15



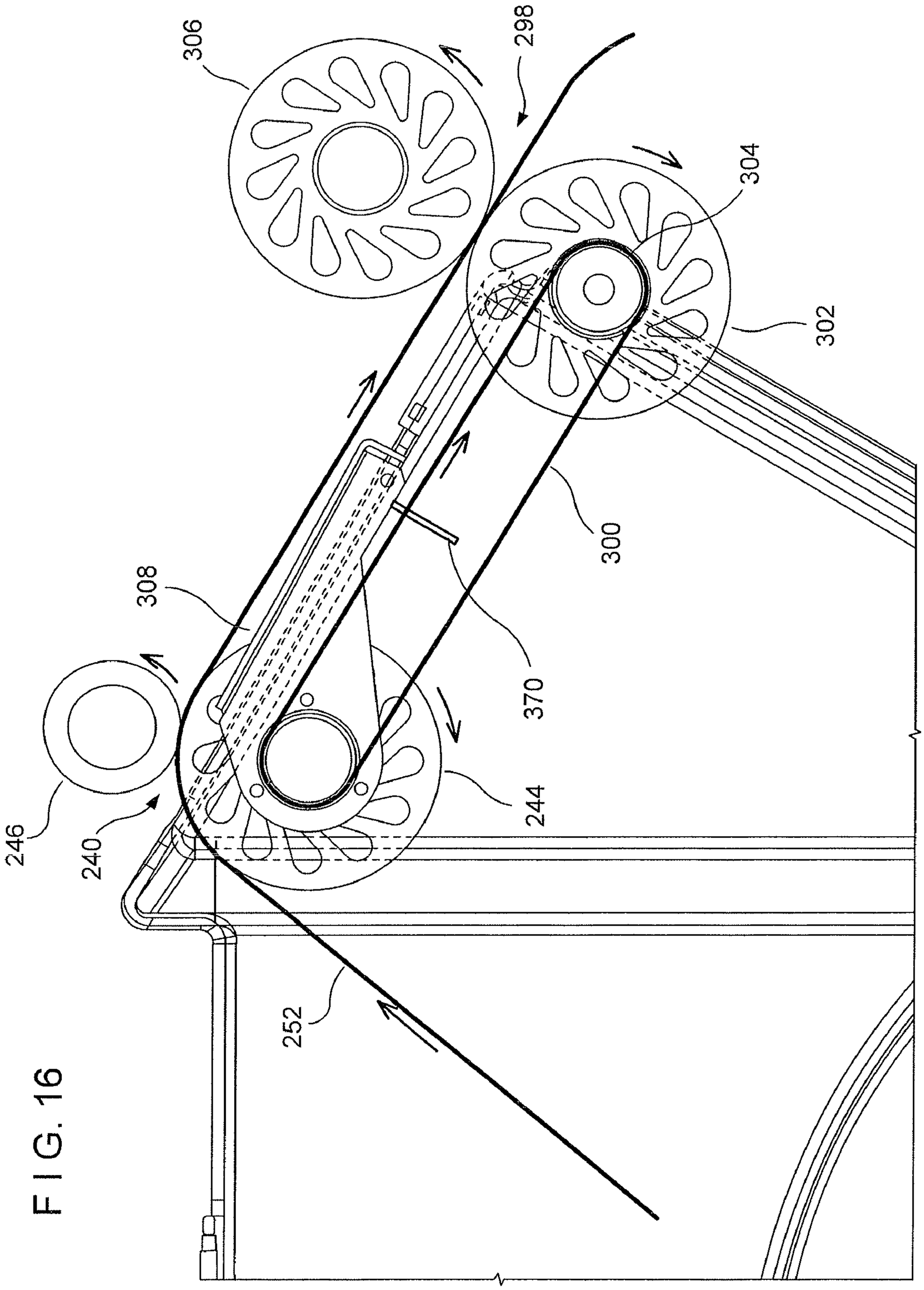


FIG. 16

APPARATUS FOR CRUMPLING PAPER SUBSTRATES

The present invention is a continuation of U.S. patent application Ser. No. 12/824,932, filed Jun. 28, 2010, now U.S. Pat. No. 8,016,735 issued on Sep. 13, 2011, which is a continuation of U.S. patent application Ser. No. 12/008,166, filed Jan. 9, 2008, now U.S. Pat. No. 7,771,338, issued on Aug. 10, 2010, which is a continuation-in-part application of U.S. patent application Ser. No. 11/811,862, filed on Jun. 12, 2007, now U.S. Pat. No. 7,744,519, issued on Jan. 29, 2010, which claimed priority to U.S. Provisional Patent Application No. 60/844,565, filed on Sep. 14, 2006, U.S. Provisional Patent Application No. 60/853,585, filed on Oct. 23, 2006, and U.S. Provisional Patent Application No. 60/906,761 filed on Mar. 12, 2007, each of which is expressly incorporated herein in its entirety.

TECHNICAL FIELD

The present invention relates generally to a system and a method for crumpling paper substrates. Specifically, the system and method provide for the crumpling of paper substrates to form fill or cushioning material to be utilized in product packaging to fill void space and/or to wrap around products thereby allowing for safe transport of the products.

BACKGROUND

It is generally known to transport and/or store products. Products to be transported and/or stored typically are packed within a box or other container. However, in most instances, the shape of the product does not match the shape of the container. Most containers utilized for transporting products have the general shape of a square or rectangular box and, of course, products can be any shape or size. To fit a product within a container and to safely transport and/or store the product without damage to the product, the void space within the container is typically filled with a packing or cushioning material.

The packing material utilized to fill void space within a container is typically a lightweight, air-filled material that may act as a pillow or cushion to protect the product within the container. In many circumstances, a plastic bubble material is utilized to protect and cushion the product contained within a container. However, plastic bubble material, and the process for making the plastic bubble material, can be expensive and time-consuming to produce. In addition, plastic bubble material is not adequate form-filling material in many instances, requiring specially made shapes and/or bubble patterns to effectively protect and cushion a product within a container during transport and/or storage. Plastic bubble material is also not "environmentally friendly" in that these materials are not readily biodegradable when exposed to the environment.

Small Styrofoam nuggets or "peanuts" may also be utilized to fill void space within containers for protecting and cushioning a product within a container during transport and/or storage. These nuggets or "peanuts" are also expensive to produce, and may not adequately protect a product unless a great number are used within the container to entirely fill the void space within the container. In addition, it is also difficult to contain the Styrofoam nuggets or "peanuts" within the container, especially after the container has been opened. These materials are typically extremely lightweight, and can easily blow away if caught within a wind or draft. These materials may also cause environmental degradation, as they are not readily biodegradable.

Another typical material utilized for filling void space within containers, and for protecting and cushioning a product contained within the container, is paper and/or paper substrates. Typically, sheets of paper material may be crumpled so as to form long shapes having many folds or pleats. Lengths of crumpled paper may be created to easily and effectively fill void space within a container holding a product. Because the paper has fold spaces and/or pleats, the crumpled paper may be very effective at protecting and cushioning a product contained within the container, and may effectively prevent damage to the product during transport and/or storage.

Sheets of paper may be crumpled by hand, in that a person may take a length of a sheet of paper, and crumple the paper to form various shapes to fill void space within a container to protect and cushion a product contained therein. However, hand crumpling paper takes much time, and is not effective and/or efficient to provide a large amount of crumpled paper as may be needed in a production line. Machines, therefore, are necessary to crumple paper.

Typical machines utilized to crumple paper generally take a length of a sheet of paper, and feed the paper into a crumpling zone of the machine to provide a crumpled paper product. However, typical machines suffer from a host of problems. For example, long sheets of paper substrate material are typically provided on rolls and are fed into machines at a high rate of speed. It is difficult to control the rate of speed for the paper substrate to be removed from the roll. Without a braking mechanism, the roll unwinds at a higher rate of speed than the paper is being fed into the machine causing paper to spill off the roll. Typically, this occurs when the rate of paper being fed into the crumpling machine slows, and momentum causes the roll, which is heavy with paper, to continue rolling. A need exists, therefore, for a crumpling machine having an adequate braking mechanism to solve this problem.

In addition, typical braking mechanisms utilized for rolls of paper sheeting involve a system utilizing an axis bar that is disposed entirely through the core of a paper roll. A tensioned washer or disk is typically provided on either or both sides of the paper roll that may apply pressure to one or both of the side surfaces of the paper rolls to prevent the roll from spinning when the machine is not ready to receive paper, thereby preventing spillage of the paper off the roll. This braking mechanism, however, is typically extremely heavy and bulky, in that it requires a heavy metal axis bar that must then be dropped within arms to hold the paper roll in place. It is difficult to quickly and efficiently remove and add paper rolls to paper crumpling machines utilizing a braking mechanism as described above. A need exists, therefore, for a braking mechanism and paper roll-holding mechanism allowing for easy and efficient removal and replacement of paper rolls.

Moreover, typical machines utilized for crumpling paper do not adequately distribute load laterally across the paper from end to end. Frequently, long sheets of paper substrate may tear when being fed within the paper crumpling machine. Typically, this occurs due to tension applied to the edges of the paper sheet, which is typically the weakest part of the paper sheet. Small fissures or tears in the edges of the paper sheeting can become large tears, or tears that completely traverse the paper sheeting, when tension is applied to the edges of the paper sheeting. A need exists, therefore, for a paper sheeting guide that allows paper sheeting to be fed into a paper crumpling machine without causing unnecessary tears or rips in the paper sheeting.

In addition, tension may be unevenly distributed longitudinally causing problems during the crumpling process of the paper sheeting, especially through the feed mechanism. Uneven shapes or thicknesses of the crumpled paper, in addition to differences in paper feed rates, may cause slippage of the paper sheeting through the crumpling machines. A need exists, therefore, for a crumpling process and/or feed mechanism that automatically adjusts tension based on the shape, thickness and/or speed of the crumpled paper fed therethrough.

Typical crumpling machines utilize, generally, hard materials for feeding and/or crumpling paper fed therethrough. Specifically, metal cylinders, with or without teeth, may be utilized for feeding paper through the machine. The hardness of the feeding and/or crumpling mechanism may be directly responsible for lateral tears or rips of the paper sheeting, and may typically produce an abundance of noise during the paper crumpling process. In addition, metal, or other hard feeding and/or crumpling mechanisms, may not provide adequate traction for the paper sheeting fed therethrough. A need, therefore, exists for a feeding and/or crumpling mechanism made from relatively soft materials that may solve the problems associated with utilizing metal in the feeding and/or crumpling mechanisms.

Moreover, a paper crumpling machine should allow for the tearing of the crumpled paper when desired. Typically, a knife may be utilized to cut the crumpled paper such that individual lengths of crumpled paper may be produced. Typical knives utilized for cutting lengths of crumpled paper can be dangerous, especially since the blade can be exposed in an area of the crumpling machine that typically requires an individual to place his or her hands therein to pull paper therethrough for setting up or clearing a jam from the machine. A need exists, therefore, for a cutting mechanism that is safe and does not injure an individual that must place his or her hands in the machine to feed the paper therethrough.

In addition, a paper crumpling machine should also allow for efficient loading of the successfully crumpled paper into a container for storage or transport. The crumpled and cut paper should exit the crumpling machine with minimal or no buildup that could jam the machine. Typical paper crumpling machines that steer or manipulate the paper into a container as the paper is moving can cause the paper to backup and jam the apparatus, for example, by causing buildup of material near the drive rollers. A need exists, therefore, for a machine comprising an exit zone that efficiently moves crumpled and cut material away from the crumpling zone and cutting mechanism, and into a suitable container.

SUMMARY

The present subject matter relates generally to a system and a method for crumpling paper substrates. Specifically, the system and method provide for the crumpling of paper substrates to form dunnage or fill material to be utilized in product packaging to fill void space and/or to wrap around products thereby allowing for safe transport of the products.

To this end, in an embodiment of the present invention, a paper crumpling apparatus is provided. The paper crumpling apparatus comprises a paper feeder for feeding paper sheeting, wherein said paper feeder comprises a guide having a plurality of tines for guiding the paper sheeting; and a paper crumpling zone wherein said paper crumpling zone crumples the paper sheeting fed thereinto by the paper feeder.

In an alternate embodiment of the present invention, a paper crumpling apparatus is provided comprising a paper feeder for feeding paper sheeting; and a crumpling zone wherein said crumpling zone crumples the paper sheeting fed thereinto by the paper feeder, wherein said paper feeder comprises a brake arm having a tapered cap for disposing in an opening of a paper roll such that the cap brakes the spin of the paper roll.

In a further alternate embodiment of the present invention, a paper crumpling apparatus is provided comprising a paper feeder for feeding paper sheeting; a crumpling zone wherein the crumpling zone crumples the paper sheeting fed thereinto by the paper feeder; and a tensioner for supplying tension to the paper sheeting, wherein said tensioner increases tension on the paper sheeting when a rate of feeding the paper sheeting into the crumpling zone increases.

In addition, in a further alternate embodiment, a paper crumpling apparatus is provided comprising a paper feeder for feeding paper sheeting; a crumpling zone wherein the crumpling zone crumples the paper sheeting fed thereinto by the paper feeder; a paper cutter; and a drive for alternately feeding the paper sheeting into the crumpling zone and cutting the paper with the paper cutter.

Moreover, in a still further alternate embodiment of the present invention, a paper crumpling apparatus is provided comprising a paper feeder for feeding paper sheeting; a crumpling zone wherein the crumpling zone crumples the paper sheeting fed thereinto by the paper feeder; a paper cutter for cutting the paper sheeting after being crumpled in the crumpling zone, wherein said paper cutter comprises a blade, wherein said paper cutter comprises a protective bottom plate section and further wherein said blade extends from said protective bottom plate section when said paper cutter cuts the paper sheeting.

In a further alternate embodiment of the present invention, a paper crumpling apparatus cutting mechanism is provided comprising a pusher, wherein said pusher comprises at least one arm attached to at least one rod driven by a motor, a blade, and a protective bottom plate section, wherein said bottom plate section prevents the blade from being exposed unless the rods are engaged by a motor causing the pusher to compress the bottom plate section thereby exposing the blade and cutting the paper.

In a still further alternate embodiment of the present invention, a paper crumpling apparatus tearing mechanism is provided comprising a pusher, wherein said pusher comprises at least one arm attached to at least one rod driven by a motor, a bottom plate section, and perforated paper, wherein said rod, when engaged by the motor, pulls the pusher down onto the bottom plate section thereby clamping the perforated paper between the pusher and the bottom plate section.

Moreover, in a still further alternate embodiment of the present invention, a paper crumpling apparatus is provided comprising a brake arm having a tapered cap for disposing in an opening of a paper roll such that the cap brakes the spin of the paper roll as paper sheeting is removed from said paper roll; a paper feeder for feeding paper sheeting, wherein said paper feeder comprises a guide having a plurality of tines for guiding the paper sheeting; a crumpling zone wherein the crumpling zone crumples the paper sheeting fed thereinto by the paper feeder; a tensioner for supplying tension to the paper sheeting, wherein said tensioner increases tension on the paper sheeting when a rate of feeding the paper sheeting into the crumpling zone increases; a paper cutter; and a drive for alternately feeding the paper sheeting into the crumpling zone and cutting the paper sheeting with the paper cutter.

In a further alternate embodiment of the present invention, a paper crumbling apparatus is provided comprising a paper feeder for feeding paper sheeting; and a crumpling zone wherein said crumpling zone comprises a door that is remov-

ably attached to one or more guide rollers, wherein one or more guide rollers may disengage from the paper sheeting upon overload of paper sheeting in the crumpling zone and/or upon opening of a machine door by an operator.

In a further alternate embodiment, a paper crumbling apparatus is provided comprising a cutting mechanism wherein said cutting mechanism comprises a blade that is semi-rigidly attached to one or more mounting blocks, wherein the angle of contact of said blade to said paper may be change within the range of motion permitted to the blade within a mounting slot.

BRIEF DESCRIPTION OF THE DRAWINGS

The drawing figures depict one or more implementations in accord with the present concepts, by way of example only, not by way of limitations. In the figures, like reference numerals refer to the same or similar elements.

FIG. **1** illustrates a perspective view of a paper substrate crumpling apparatus in a particularly preferred embodiment of the present invention.

FIG. **2** illustrates a side perspective view of a paper roll and braking mechanism in an embodiment of the present invention.

FIGS. **3**A-**3**B illustrate views of a paper sheeting feed guide and feed rollers, as a portion of the crumpling machine in an embodiment of the present invention.

FIGS. **4**A-**4**B illustrate a top cut-away perspective view and a side cut-away view of a feed/crumple mechanism in an embodiment of the present invention.

FIG. **5** illustrates a front perspective view of a cutting mechanism for the paper sheeting in an embodiment of the present invention.

FIG. **6** illustrates a close-up view of the cutting mechanism in an embodiment of the present invention.

FIG. **7** illustrates a side perspective view of a cutting mechanism for the paper sheeting in an embodiment of the present invention.

FIG. **8** illustrates a side view of a cutting mechanism for the paper sheeting in an embodiment of the present invention.

FIG. **9** illustrates an elevated perspective view of a cutting mechanism for the paper sheeting in an embodiment of the present invention.

FIG. **10** illustrates a side view of a tearing mechanism for the paper sheeting in an embodiment of the present invention.

FIG. **11** illustrates a side perspective view of a cutting mechanism for the paper sheeting in an embodiment of the present invention.

FIG. **12** illustrates a side cut-away view of a cutting mechanism in an embodiment of the present invention, during normal operation.

FIG. **13** illustrates a side cut-away view of an embodiment of the present invention, during an overload condition.

FIG. **14** illustrates a cut-away perspective view of a cutting mechanism for the paper sheeting in an embodiment of the present invention.

FIG. **15** illustrates a close-up view of the blade mounting system for the mechanism shown in FIG. **14**.

FIG. **16** illustrates a side view of a paper crumpling apparatus with an exit zone in an embodiment of the present invention.

DETAILED DESCRIPTION OF THE PRESENT PREFERRED EMBODIMENTS

The invention and embodiments described herein relates generally to a system and a method for crumpling paper substrates. Specifically, the system and method provide for the crumpling of paper substrates to form fill material to be utilized in product packaging to fill void space and/or to wrap around products thereby allowing for safe transport of the products.

Illustrative embodiments will now be described to provide an overall understanding of a paper crumpling system and a method for crumpling paper. One or more examples of the illustrative embodiments are shown in the drawings. Those of ordinary skill in the art will understand that each disclosed embodiment or portion of the paper crumpling system and method of crumpling paper can be adapted and modified to provide alternative embodiments, and that other additions and modifications can be made to the disclosed paper crumpling system and method of crumpling paper without departing from the scope of the present disclosure. For example, features of the illustrative embodiments can be combined, separated, interchanged, and/or rearranged to generate other embodiments. Such modifications and variations are intended to be included within the scope of the present disclosure.

Unless otherwise provided, when the articles "a" or "an" are used herein to modify a noun, such articles can be understood to include one or more than one of the modified noun.

Referring now to the figures, wherein like numerals refer to like parts, FIG. **1** illustrates a paper crumpling apparatus **10**. The paper crumpling machine **10** generally takes in paper sheeting **12**, typically provided on a roll **14**, and feeds said paper sheeting **12** into the paper crumpling machine **10** through a paper crumpling zone **11**. The paper crumpling apparatus **10** crumples the paper sheeting **12** in a generally longitudinal pattern, thereby putting a series of longitudinal folds and/or pleats within the paper sheeting **12**. The paper sheeting **12** exits the paper crumpling apparatus **10** via an exit **16**. The crumpled paper can be added directly to a box or other container for filling void space within the box thereby protecting a product contained therein from damage during transport and/or storage of the product. Alternatively, the crumpled paper may be collected and stored and added to a box or container at a later time.

The paper sheeting **12** may be any size or kind apparent to one having ordinary skill in the art that is sufficiently wide to enter the paper crumpling apparatus **10** and have folds and/or pleats applied thereto. Typically, the paper sheeting **12** is anywhere between about 15 inches and about 36 inches, although any other width may be utilized. Moreover, the paper sheeting may be made from virgin paper fibers and/or recycled paper fibers, such that the paper sheeting has sufficient strength to be taken from the roll **14** and fed through the paper crumpling machine without unreasonable tearing or ripping thereof. The paper sheeting **12** may further have perforations pre-pressed into the paper at set intervals to allow for intentional tearing of the paper.

In a preferred embodiment of the present invention, illustrated in FIG. **2**, the roll **14** of the paper sheeting **12** sits on a platform **20**. The roll **14** sits on at least one arm **22** having an upper surface **26**. The upper surface **26** may provide a contact surface for the roll **14**. Specifically, the upper surface **26** may be curved, as illustrated in FIG. **2**, to generally contour to the shape of the roll **14** to optimize the amount of surface area of the upper surface **26** contacting the roll **14**. However, the present invention should not be limited in this way, and the upper surface **26** may be any shape and may provide any amount of surface area for contacting the roll **14**. Moreover, any number of arms may be utilized to hold the roll **14**, including a single arm, or a plurality of arms, each having an upper surface for the roll **14** to be disposed thereon.

The upper surface **26** provides a first portion of a brake mechanism that prevents the paper sheeting **12** on the roll **14** from uncontrolled unrolling or unraveling, such as would happen when the roll **14** rolls at a faster rate than the paper crumpling apparatus **10** feeds the paper sheeting **12** therethrough. For example, if the paper crumpling apparatus **10** takes up paper sheeting **12** at a first rate, then slows down suddenly to a second rate, the momentum of the roll **14** may cause the rate of the spin of the roll **14** to remain fast, if there is no braking mechanism to keep the roll **14** from rolling at the faster rate. The friction of the roll **14** on the upper surface **26** of the arm **22** provides the braking mechanism, in that the weight of the roll **14** on the upper surface **26** provides sufficient friction to prevent the paper sheeting **12** from uncontrolled unrolling. The friction of the upper surface **26** and the roll **14** may be influenced by a host of factors, including the material utilized for the upper surface **26**, the shape of the upper surface **26**, and/or the type of paper being fed.

The roll **14** may further be removably engaged or otherwise connected to an brake arm **30** that is engaged to an open end of the core of the roll **14** of the paper sheeting **12** via a cap **32**. The cap **32** fits within the open end of the core of the roll **14** and contacts the inside surface of the core of the roll **14**. The core of the roll **14** is typically a tube of rigid material, such as cardboard, that holds the paper sheeting wrapped therearound.

To provide braking capabilities for the roll **14**, the cap **32** does not spin with the roll **14**, but provides friction to the inside surface of the core of the roll **14** to keep the roll **14** from uncontrolled unraveling. The cap **32** is tapered so as to engage the inside surface of the core of the roll **14**, and may continue to provide a friction surface if the inside surface of the open end of the roll wears down through use. A spring **34** engages the cap and allows a plunger **36** to push the cap against the opening of the roll **14** to provide the requisite friction to prevent uncontrolled unrolling or unraveling of the roll **14**. The spring further helps the cap **32** maintain engaged contact with the inside surface of the core of the roll **14** when the inside surface of the core of the roll **14** wears due to use.

To disengage the roll **14** from the paper crumpling apparatus **10**, the plunger **36** may be pulled, thereby disengaging the cap **32** from the opening in the roll **14**, and the roll **14** may be removed. Alternatively, to engage the roll **14** of the paper sheeting **12**, the plunger **36** may be pulled, thereby allowing an individual to place the roll on the upper surface **26** of the arm **22**, and the cap **32** may be fit within the opening on the side of the roll **14** formed by the core of the roll **14**.

The brake arm **30** has a pivot point **38** allowing the arm to pivot. When the cap **32** is engaged to the opening of the roll **14** of the paper sheeting **12**, the brake arm **30** has the dual function of maintaining the roll **14** in position on the upper surface **26** of the arm **22**, but to also allow the weight of the roll **14** of the paper sheeting **12** to allow the roll **14** to maintain contact with the upper surfaces **26** of the arm **22**. As the roll **14** of the paper sheeting **12** unwinds, the radius of the roll **14** decreases, and the roll **14** must fall to maintain contact with the upper surface **26** of the arm **22**. The pivot point **38** allows the brake arm **30** and, consequently, the roll **14** to fall and maintain contact with the upper surface **26** of the arm **26**.

The braking mechanism utilized to prevent the roll **14** of the paper sheeting **12** from unrolling or unraveling uncontrollably is provided by both the contact of the roll **14** with the upper surfaces **26** of the arms **22**, and the contact of the opening of the roll **14** of the paper sheeting **12** with the cap **32**. The brake arm **30** also maintains the roll **14** in position on the arm **22**. In addition, a second brake arm (not shown) may be provided on the opposite side of the roll **14** to provide the same function as the brake arm **30**, including a cap (not shown) engaged with an opening of the roll **14** of the opposite side of the roll **14**. The second brake arm may, generally, be identical to the brake arm **30**, thereby allowing engagement of the cap (not shown) with the second opening (not shown) of the roll **14**. The second brake arm on the opposite side may further have a pivot point (not shown) for allowing the second brake arm to pivot when the roll **14** unrolls during use of the paper crumpling apparatus **10**.

A storage space **40** may be provided on the arm **22** for storing a second roll **42** (not shown). When the roll **14** must be replaced, such as when all or most of the paper sheeting **12** is removed from the roll **14** and fed into the paper crumpling machine **10**, the roll **42** may be moved into position on the upper surface **26** of the arm **22** and the openings in the core of the roll **42** may engage the cap **32** and the cap on the opposite side (not shown). A third roll of paper sheeting may then be placed on the storage space **40** until the roll **42** is depleted.

FIG. **3**A illustrates a rake **50** that acts as a guide for paper sheeting **12** from the roll **14** that may be disposed below the rake **50**. The paper sheeting **12** ascends from the roll **14** and the underside thereof contacts the rake **50**, and the rake **50** guides the paper sheeting **12** toward the rollers **52**, **54** disposed near a top **56** of the rake **50**, where the total width of said paper sheeting is reduced by forming waves therein, as described below, and the paper sheeting **12** is passed through said rollers **52**, **54**.

The rake **50** may have a plurality of tines **58***a*, **58***b*, **58***c*, **58***d* and **58***e* for guiding the paper sheeting **12** toward the rollers **52**, **54**. Between the plurality of tines **58***a*-**58***e* may be a plurality of spaces **60***a*, **60***b*, **60***c* and **60***d*. The plurality of space **60***a*-**60***d* provide space for the paper sheeting **12** to be pushed or fall into, thereby creating troughs in the paper sheeting **12** as the paper sheeting **12** is fed toward the rollers **52**, **54**. FIG. **3**B illustrates a frontal view of the rake **50** having paper sheeting **12** fed thereover. As shown in FIG. **3**B, the paper sheeting **12** falls into spaces **60***a*-**60***d*, thereby introducing troughs in the paper sheeting **12**. The troughs allow the paper sheeting **12** to reduce in width for entering through the rollers **52**, **54**. Ultimately, the troughs further cause longitudinal folds and/or pleats to be formed in the paper sheeting **12** prior to exiting the paper crumpling machine **10**.

The tines **58***a*-**58***e* are shaped in such as way as to efficiently guide the paper sheeting **12** through the rollers **52**, **54**. Moreover, the tines **58***a*-**58***e* are further shaped to allow the paper sheeting **12** to form the troughs therein. A preferred embodiment of the present invention is illustrated in FIGS. **3**A-**3**B, whereby the tines **58***a*-**58***e* are curved longitudinally (i.e., in the direction of paper travel in FIGS. **3**A-**3**B), and a surface disposed laterally across the tines **58***a*-**58***e* is also curved. In addition, any number of tines may be utilized as apparent to one having ordinary skill in the art. It has been found that the number of tines, the size of the tines, and the space between the tines is influenced by the width of the paper sheeting **12**. Paper sheeting having a larger width may require more and longer tines spaced further apart than paper sheeting having a smaller width. A general rule is that the width of the rake at a lower end **57** should be approximately ⅔ the width of the paper sheeting **12**.

A horn **64** may also help guide the paper sheeting **12** through the rollers **52**, **54**. Horn arms **66**, **68** help prevent the paper sheeting from moving laterally with respect to the direction of feeding the paper sheeting through the rollers **52**, **54**. In addition, the horn arms **66**, **68** help the edges of the paper sheeting **12** to fold under the paper sheeting, thereby removing tension or load from the edges of the paper sheeting **12**. Tears or rips in the paper sheeting **12** frequently are due to

tension placed on the edges of the paper sheeting, where small fissures in the paper sheeting **12** may develop into larger and more destructive tears or rips in the paper sheeting **12**. By folding the edges of the paper sheeting **12** thereunder, the outer edge of the paper sheeting **12** becomes the first fold line disposed on opposite sides of the paper sheeting. FIG. **3**B illustrates first fold lines **70**, **72** that are disposed in the paper sheeting **12** with the aid of the horn **64** and horn arms **66**, **68**.

The rollers **52**, **54** may allow the paper sheeting **12** to traverse therethrough, and provide guidance for the paper sheeting as it moves to the next stage of the paper crumpling process. Moreover, the rollers **52**, **54** may cause a further reduction in the width of the paper sheeting **12** after passing over the rake **50**. The rollers may be made from any material, such as thermoplastic polymeric material, metal, or any other material apparent to one having ordinary skill in the art. In a preferred embodiment, the rollers **52**, **54** may be made from soft thermoplastic material, such as polyurethane, for example. The soft thermoplastic material provides increased friction when the rollers **52**, **54** contact the paper sheeting **12**, thereby reducing slippage of the paper sheeting **12** as it passes therethrough. Softer thermoplastic materials also tend to decrease the potential for damaging the paper sheeting **12** as it passes therethrough.

In this embodiment, rollers **52** and **54** together form a neck at about the end of rake **50**. The width of the paper sheeting material may be reduced as it travels through the neck area. As noted above, the neck is preferably but not necessarily formed from one or more rollers. Although FIG. **3**A illustrates two rollers (**52**,**54**), any number of rollers may be utilized to fulfill the function of guiding the paper sheeting **12** to the next stage. Moreover, the rollers **52**, **54** may be replaced by stationary pins, or other means, having a relatively hard and/or smooth surface, that act as guides for the paper sheeting **12**, and should not be limited as herein described.

FIG. **3**B illustrates a side view of the rake **50** illustrating a preferred embodiment showing the curvature of the tines both longitudinally and laterally, which maximizes the efficiency of the paper sheeting **12** fed thereover.

The next stage of the paper crumpling process involves feeding the paper substrate into a paper crumpling zone **100**, as shown in the cut-away perspective view of the paper crumpling zone **100** in FIG. **4**. In general, the paper sheeting **12**, after traveling over the rake **50**, is reduced in width by the addition of waves or troughs in the paper sheeting caused by the tines **58***a*-**58***e* and the spaces **60***a*-**60***d* between the tines **58***a*-**58***e*, and is permanently deformed, or crumpled, after passage through the paper crumpling zone **100**. The paper sheeting **12** is pressed and the waves disposed therein form folds and/or pleats within the paper sheeting **12**. These folds and/or pleats form a crumpled paper product that is usable as a dunnage or void fill for packaging.

The paper sheeting **12**, after traveling over the rake **50**, is guided under first guide roller **102** and disposed adjacent to drum **104**. The paper sheeting **12** traverses over the surface of the drum **104** and between the drum **104** and a second guide roller **106**. After passing through a space between the second guide roller **106** and the drum **104**, the crumpled paper product traverses through opening **108**. The folds and/or pleats formed within the paper sheeting **12** are formed primarily when the paper sheeting passes between the drum **104** and the second guide roller **106**.

The drum is interconnected with a drive mechanism that allows the drum to rotate in a direction so as to feed the paper sheeting **12** through the paper crumpling zone **100**. In FIG. **4**A, the drum **104** rotates counterclockwise. FIG. **4**B illustrates a cut-away side view of the paper crumpling zone **100** illustrating how the paper sheeting **12** is fed therethrough, and the direction of travel of the paper sheeting **12**. As seen, the second guide roller **106** is disposed very close to the drum **104** so that the paper sheeting **12** and waves disposed therein are crushed to form folds and/or pleats.

Near the opening **108** is a pusher **110** and a bottom plate section **136** having a first portion **138** and a second portion **140** with a blade **112** disposed therein, as shown in FIG. **7**. The blade allows the paper sheeting **12** to be cut at desired locations to form crumpled paper products of any desired length. The mechanism for allowing the blade to be exposed and cut through the paper sheeting **12** is described below with respect to FIGS. **5**-**9**. The blade **112** generally has a plurality of teeth that may puncture and slice the paper sheeting **12** fed therethrough. Since the paper sheeting **12** is provided with a plurality of folds and pleats at this point, the paper sheeting must engage the blade **12** with sufficient force to cut the paper sheeting **12** completely through.

Still referring to FIGS. **4**A-**4**B, the first and second guide rollers **102**, **106** may be made from any material useful for guiding the paper sheeting **12** and pulling the paper sheeting **12** through the paper crumpling zone **100**. Preferably, the first and second guide rollers **102**, **106** are made from a soft thermoplastic material, such as polyurethane, or other similar soft material, thereby providing a gripping mechanism on the paper sheeting without tearing the paper sheeting **12**. Specifically, first and second guide rollers made from soft material, such as polyurethane or other material, provides traction for feeding the paper sheeting **12** therethrough and roll very smoothly and without excessive noise.

The first and second guide rollers **102**, **106** are self-tensioning, and respond when the paper sheeting is fed therethrough at increased or decreased speeds. For example, if the drum **104** turns faster, the interaction of the drum **104** and the second guide roller **106** pulls the paper sheeting **12** therethrough at a faster rate. When tension is increased on the paper sheeting **12**, it causes the first guide roller to get pushed upwards by the paper sheeting material **12**. In response, a first tensioning arm **114**, interconnected with a second tensioning arm **116** through a pivot point **118**, causes the second tensioning arm **116** to push downwardly, thereby pushing the second guide roller **106** closer to the drum **104**. This has the effect of increasing the pressure applied to the paper sheeting **12** at the convergence point of the second guide roller **106** and the drum **104**, increasing quality of the folds and/or pleats disposed therein, and providing increased traction of the second guide roller **106** on the paper sheeting **12**. When speed decreases, the first guide roller **102** is allowed to fall downwardly thereby reducing tension on the second guide roller **106** and allowing the second guide roller to lift away from the drum **104** via the pivot point **118**.

FIG. **5** illustrates a side perspective view of the paper crumpling zone **100**, showing a drive mechanism and a cutter mechanism. Specifically, a first cylinder **120** is connected to a motor (not shown) for spinning said first cylinder **120** in either of two directions. A belt **122** wraps around the cylinder **120** through a plurality of guide cylinders **123***a*, **123***b* and ultimately engages a second cylinder **124** that is directly attached to the drum **104**, as shown in FIGS. **4**A-**4**B. The second cylinder **124** may be connected to the drum **104** by a clutch bearing (not shown) such that the drum **104** may only spin in one direction (counterclockwise in the view shown in FIG. **5**). When the first cylinder **120** spins counterclockwise, the belt engages the second cylinder **124** and spins the second cylinder **124** counterclockwise, thereby spinning the drum **104**, which feeds the paper sheeting through the paper crumpling zone **100**. However, when the motor reverses, the first

cylinder **120** spins in a clockwise direction, and the second cylinder **124** also spins in a clockwise direction, but the clutch bearing does not allow the drum **104** to spin. Therefore, the drum **104** may only spin when the second cylinder **124** spins in one of the two directions via the motor (not shown). Alternatively, the first and second cylinders **120**, **124**, and hence, the paper feed mechanism and the cutter mechanism, may be driven by two independent motors (not shown).

A crank **126** may be attached to the first cylinder **120**, and may further be attached thereto with a second clutch bearing (not shown), such that the crank **126** may only spin when the first cylinder turns in one of the two directions. In the present embodiment, the crank **126** only spins when the first cylinder **120** spins in a clockwise direction, in the view shown in FIG. **5**. The crank **126** is attached to an arm **128** that is attached to the head **110**. When the crank **126** spins, the arm **128** may move linearly, or mostly linearly, thereby pulling the head **110** in a downward direction. The head **110** may be attached to the pivot point **118**, or other pivot point via the extension arm **132**, allowing the head **110** to move upwardly or downwardly, as necessary.

The first cylinder **120**, the second cylinder **124**, the crank **126**, the arm **128** and the clutch bearings (not shown) allow either a single motor or two separate motors to drive both the paper feed mechanism and the cutting mechanism of the paper crumpling apparatus **10** of the present invention. If a single motor is utilize, the paper feed mechanism and cutter mechanism may operate by merely reversing the rotation of the drive.

Attached to the head **110** is a first pusher **142** and a second pusher **144** which may further traverse in the downward direction when the head **110** moves in the downward direction, caused by the pulling of the arm **128** via the crank **126**, as shown in FIGS. **6-7**. The first pusher **142** and the second pusher **144**, when pulled down against the first portion **138** and the second portion **140** of the bottom plate **136** expose the blade **112**, and the blade **112** may cut the paper sheeting **12** that may be disposed through the opening **108**. The head **110** may further have a receiving material **130**, the receiving material **130** may be located between the first pusher **142** and the second pusher **144**, as shown in FIG. **8**. When the blade **112** is exposed to cut the paper sheeting **12**, the receiving material **130** accepts the blade **112**. This allows an individual to manipulate the paper crumpling apparatus **110**, such as to replace parts or fix a paper jam, or the like, with reduced chances of being injured by the blade **112**. The receiving material also assists the blade **112** with cutting the paper sheeting **12** by placing additional pressure on the cutting point of the paper. Moreover, the receiving material **130** further protects the blade **112** while the machine is in use, increasing the lifespan of the blade **112**.

FIGS. **6-7** further illustrate the head **110** having the first pusher **142** and the second pusher **144** extending therefrom. When the head **110** moves downwardly, the first pusher **142** and the second pusher **144** make contact with the first section **138** and the second section **140** of the bottom plate **136**. The first section **138** and the second section **140** of the bottom plate **136** may be made from either a resilient material or supported through the use of springs. The resilient material may be sponge-like or some other material known in the art that when pressed will compress sufficiently to expose the blade **112** contained between the first section **138** and the second section **140**. Similarly, if the first section **138** and the second section **140** are spring loaded, the spring (not shown) should provide an amount of tension such that when the first pusher **138** and the second pusher **140** are brought into contact with the first section **138** and the second section **140** and apply pressure thereto, the spring will compress and expose the blade **112** located between the first section **138** and the second section **140**. The blade **112** should be strong enough to fully cut the paper sheeting **12** when the paper sheeting **12** is crumpled. The blade **112** may further have a plurality of sharpened teeth allowing easy cutting of the paper sheeting disposed beneath.

FIGS. **8-9** illustrate a side view of the cutting mechanism of the paper crumpling machine **10**. As shown, the first section **138** and the second section **140** of the bottom plate **136** are at different elevations with respect to each other. The first pusher **142** and the second pusher **144** are at different lengths to accommodate the different elevations of the first section **138** and the second section **140** of the bottom plate **136**. When the first pusher **142** and the second pusher **144** are moved in a downwardly direction, the paper sheeting **12** is pressed between the first pusher **142** and the first section **138** of the bottom plate **136** and further between the second pusher **144** and the second section **140** of the bottom plate **136**. The different elevations of the first section **138** and the second section **140** of the bottom plate **136**, cause the paper sheeting **12** to be crimped, thereby compressing the end of the paper sheeting **12** that is cut or torn, allowing the paper **12** to be bound tightly preventing the paper sheeting **12** from unraveling or flattening out after the cut or tear has been made. The different elevations of the first section **138** and the second section **140** of the bottom plate **136** also facilitate the section of cut or torn paper sheeting **12** falling away from the cutting mechanism following the cutting or tearing.

In another embodiment, illustrated in FIG. **10**, the head (not shown) moves downwardly, causing a first pusher **146** and a second pusher **148** to clamp the paper sheeting **12** between the first pusher **146**, the second pusher **148** and the first section **150** and the second section **152** of the bottom plate **136**, as shown in FIG. **10**. The paper sheeting **12** has perforations **154** that may be located at or near the outside edge of the first pusher **146**. When the paper sheeting **12** is clamped, tension may be applied to the paper sheeting **12** by either an additional mechanism or a user, causing the paper sheeting **12** to tear along the perforation **154**. In this embodiment, the blade **112** is not present, thereby allowing for safer operation and for ease of use.

In a further embodiment, illustrated in FIG. **11**, a blade **212** is attached to a head **210** that may traverse in a downward direction when the head **210** moves in the downward direction, caused by the pulling of an arm **228**. The blade **212** may cut the paper sheeting. A slot **234** may be contained under the blade **212** for accepting the blade **212** when the blade **212** is fully extended. This allows the blade **212** to fully pierce and cut the paper sheeting **12** that may be positioned beneath the blade **212**. The blade **212** should be strong enough and sharp enough to fully cut the paper sheeting **12** when the paper sheeting **12** is crumpled. The blade **212** may further have a plurality of sharpened teeth allowing easy cutting of the paper sheeting disposed beneath.

The head **210** may further have a safety sleeve **230** that is blocked from moving when the head **210** and the blade **212** move downwardly. The safety sleeve **230** generally covers the blade **212** when the blade **212** is in the upward position, but allows the blade **212** to be exposed when the blade **212** moves downwardly. This allows an individual to manipulate the paper crumpling apparatus **10**, such as to replace parts or fix a paper jam, of the like, with reduced chance of being injured by the blade **212**. Moreover, the safety sleeve **230** further protects the blade **212**, increasing the lifespan of the blade **212**.

In a further embodiment, a crumpling apparatus with a magnetic engagement/door mechanism is shown in FIGS. **12-13**. In FIG. **12**, the paper crumpling apparatus comprises a crumpling zone **240** having a guide roller **242**, drive roller **244**, and pinch roller **246**, which help guide paper sheeting **252** through the crumpling zone **240**. As in previous embodiments, any number of rollers may be used, extending across some or all of the width of the paper sheeting **252** traveling through the machine.

Pinch roller **246** is mounted on bracket **248**. Bracket **248** connects to pivot shaft **250**, which is also connected to door **254**. The connection of bracket **248** and door **254** to pivot shaft **250** allows, under certain conditions, door **254** and bracket **248** to pivot relative to one another around the axis of pivot shaft **250**. During normal operation the crumpling apparatus in this embodiment, bracket **248** is held to the underside of door **254** by means of a magnet **256** or similar attachment device. Multiple magnets may also be used, and the size, strength, and number of magnet(s) may vary depending on the strength of the attraction desired between the bracket **248** and the door **254**. In addition, while the present embodiment describes one or more magnets, other like means may be utilized to hold the door **254** to the bracket **248**, such as clips, hooks, hook-and-loop mechanisms (commonly referred to as VELCRO®), adhesives, or other like means.

The door **254** may have a handle **258** and, as describe above, may rotate around pivot shaft **250**. When access to the crumpling zone **240** is desired by a user, technician, or other individual desiring access, the handle **258** may be lifted, causing the door **254** to rotate up and away from the crumpling zone **240**, thereby allowing an individual to gain access to the crumpling zone. Pulling the handle **258** upwards disengages door **254** from bracket **248** by breaking the magnetic attraction of the magnet **256** to the door **254**.

When door **254** is held by magnet **256** to bracket **248**, door **254** is prevented from pivoting relative to bracket **248**. In this configuration, guide roller **242** and pinch roller **246** may be considered rigidly attached to one another, because both are attached to the combination of door **254** and bracket **248** held together by magnet **256**. This configuration allows pinch roller **246** and guide roller **242** to act in concert to provide traction to guide paper sheeting **252** as it traverses through the crumpling apparatus, so that paper sheeting **252** therein is crushed to form folds and/or pleats. The pinch roller **246** and guide roller **242** operate similarly to rollers described in previous embodiments.

The attraction between magnet **256** and door **254** also allows the pinch roller **246** to tighten against paper sheeting **252** as material tension increases. This may occur, for example, when paper sheeting **252** is fed from a new roll, when paper sheeting **252** traverses the apparatus at accelerating speed, or when required by the material properties of the particular paper feed stock.

As in previous embodiments, the guide roller **242** and the pinch roller **246** are interconnected via the pivot shaft **250**. As tension increases on the guide roller **242**, such as when the paper sheeting traverses the apparatus at accelerating speed, the increased tension on the guide roller **242** may cause it to pivot upwards, thereby causing a corresponding downward pivot of the pinch roller **246** against the paper sheeting **252**, thereby increasing the traction of the pinch roller **246** and the paper sheeting **252**. In an alternate embodiment, magnets or other like connecting mechanisms may not be used, and the pivot shaft may be tensioned, thereby providing the requisite downward force of the pinch roller **246** against the paper sheeting **252**.

FIG. **13** illustrates paper crumpling apparatus **240** in an "overload" condition, in which pinch roller **206** is lifted away from drive roller **244** and disengaged from the paper sheeting (not shown). Disengagement may occur when paper sheeting jams in the area between the drive roller **244** and pinch roller **246**. If the accumulated material exerts an upward lifting force on pinch roller **246** which exceeds the force of magnet **256**, then pinch roller **246** may be lifted, causing magnet **256** to disengage from door **254**, and in turn, causing bracket **248** to pivot relative to door **254**. When this occurs, guide roller **242** and pinch roller **246** no longer act in concert to apply tension to paper sheeting **252**. Although drive roller **244** may continue to spin, disengagement of the traction provided by guide roller **242** and pinch roller **246** may prevent paper sheeting from continuing to be fed through the apparatus.

In the event that sufficient paper becomes trapped in the area of pinch roller **246**, the present embodiment provides a mechanism for pinch roller **246** to automatically disengage from the paper sheeting, preventing further backup. This may conserve paper sheeting stock and prevent possible damage to components of the paper crumpling apparatus. In addition, if the handle **258** is lifted (shown in FIG. **13**) to open door **254**, this can cause magnet **256** to disengage from door **254**, and in turn, pinch roller **246** to disengage from the paper sheeting. This stops movement of paper sheeting through the apparatus when the door **254** is opened and the inner components the apparatus are exposed, to allow the operator to more safely examine the apparatus. Therefore, an operator of the apparatus may automatically disengage the pinch roller **246** from the paper sheeting **252**, if necessary, merely by lifting the handle **258**.

FIG. **14** illustrates a paper cutting blade mounted in a chassis **268** of a paper crumpling apparatus. Blade **270** is partially enclosed by platen **272**. Platen **272** contains a slot **274** which allows the teeth of the blade **270** to be exposed to the paper sheeting (not shown) as it progresses through the crumpling apparatus. As shown in this embodiment, slot **274** can be wider than the width of blade **270**. As further described below, blade **270** may be mounted such that it is not held completely rigid within slot **274**. This configuration allows blade **270** to move or wobble back-and-forth within the width of slot **274**. This is advantageous in some circumstances because allowing blade **270** to wobble within slot **274** permits the teeth and/or sharp edge of blade **270** to contact the paper sheeting at slightly different angles of contact. Altering the angle of contact may enhance the effectiveness of blade **270** at cutting the paper sheeting, depending upon the physical properties of the particular paper sheeting, the configuration and wear on blade **270**, and other factors. Thus permitting blade **270** to wobble within slot **274** helps blade **270** naturally find the optimal angle of contact to the paper, within the range of motion that is permitted by both the width of slot **274** and the rigidity with which blade **270** is attached to mounting blocks **276**.

As shown in FIG. **14**, Blade **270** may be attached to mounting blocks **276**. In the embodiment shown, two mounting blocks **276** help secure blade **270** at either end. Each mounting block **276** contains a slot or groove within which blade **270** is fitted. Each mounting block **276** on either side of the blade **270** need not be one-piece, but instead may comprise multiple blocks on either ends and sides of blade **270**. Mounting blocks **276** can be held together by screws or like fastening devices, or even more permanently affixed to adjacent components of the crumpling apparatus, such as chassis **268**. Alternatively, one or more mounting blocks can run along the entire length of blade **270**, rather than just the ends, if added support is needed. In addition, the width of the slot or groove

in mounting blocks **276** and/or the width of slot **274** may be adjusted to accommodate blades of differing width and/or to adjust the desired wobble of blade **270**.

In the embodiment shown, blade **270** is secured within mounting blocks **276** by upper screws **278** and lower screws **280**. Any number of screws or like fastening devices may be used, depending upon the desired blade **270** chosen, as well as the preferred mounting configuration. Optionally, mounting blocks **276** may contain any number of additional holes **282**, which would allow the machine operator to use cutting blades of different length and/or blades which contain differently spaced mounting holes. The additional holes avoid the necessity of changing other components within the apparatus to accommodate a different blade.

FIG. **15** shows a closer view of blade **270** mounted in a configuration according to the embodiment shown in FIG. **14**. Lower screw **280** serves as a lower support for blade **270**. Support may be provided, however, from means other than a screw, such as a slot within mounting block **276**, or other component. Thus, separate upper and lower screws are not necessary. In addition, multiple extra holes (not shown) can be made in mounting block **276**, which would allow a machine operator to adjust the height of the lower support as necessary in order to adjust the height of the blade and/or in order to accommodate blades of differing height.

As shown, upper screw **278** extends through mounting block **276** and blade **270**, to the backside of blade **270** and the other end of the mounting block **276**. The hole made in blade **270** to accommodate upper screw **278** may be made larger than strictly necessary to accommodate upper screw **278**. Creating a larger hole in blade **270** further facilitates the ability of blade **270** to wobble or move within slot **274** of FIG. **14**, because then upper screw **278** is not attached to blade **270** with complete rigidity.

Creating a larger than necessary hole through blade **270** to accommodate screw **278** may have the effect of allowing blade **270** to wobble slightly upwards in FIG. **15**. A magnet **284** may be placed in mounting block **276**, thereby keeping the bottom of blade **270** securely affixed to the lower support (such as lower screw **280**). Magnet **284** can be installed or removed through slot **285**.

The arrangement shown in FIG. **15** thus keeps blade **270** affixed to the lower support, preventing blade **270** from moving upward, but it also allows blade **270** to beneficially wobble from side-to-side within slot **274** of FIG. **14**. To secure blade **270**, the size and strength of magnet **284** may be varied according to need, and multiple magnets may be employed. Alternatively, a different fastening mechanism altogether may be used to keep blade **270** affixed to a lower support, such as a VELCRO™ hook and loop fastener, adhesives, or similar means.

FIG. **16** shows a side view of a paper crumpling apparatus with an exit zone **298**, in an embodiment of the present invention. An apparatus in accordance with this embodiment may comprise a crumpling zone **240** having a drive roller **244** and a pinch roller **246** which help guide the paper sheeting **252** through the crumpling zone **240**. As in previous embodiments, any number of rollers may be employed, across some or all of the width of the apparatus. Drive roller **244** may be driven directly by a motor or by a gearbox mechanism (not shown).

Exit zone **298** comprises a first exit roller **302**, which may be connected to drive roller **244** by a belt **300**. Belt **300** could also be a chain or similar mechanism suitable for driving rotation of first exit roller **302**. Alternatively, first exit roller **302** may have its own independent drive mechanism. First exit roller **302** may have a clutch **304**, which allows for first exit roller **302** to disengage from the rotational force provided by belt **300** and for first exit roller **302** to freely spin on its own. Clutch **304** can be "one-way," allowing first exit roller **302** to freely rotate only in one direction. Allowing first exit roller **302** to disengage from the rotation provided by belt **300** allows for easier and safer clearing of paper that may be built up or jammed in the crumpling apparatus. When no rotational force is being provided to first exit roller **302**, clutch **304** still allows for rotation of first exit roller **302**, so that an operator may remove any paper remaining in exit zone **298**.

In addition, exit zone **298** ideally comprises a second exit roller **306** to help guide the crumpled and cut paper into a container (not shown). The use of a pair of exit rollers helps guide the leading edge of the paper through the exit of the apparatus. However, in place of exit roller **306**, a frame, plate, or other structure may be used which, in conjunction with first exit roller **302**, channels the paper to exit the crumpling apparatus.

As with the rollers in the crumpling zone, first exit roller **302** and second exit roller **306** may be comprised of any number of rollers, across some or all of the width of the entire paper crumpling apparatus. Further, first exit roller **302** and second exit roller **304** may be configured with optional features similar to the drive roller configurations discussed in previous embodiments of the present invention.

In FIG. **16**, the embodiment shown includes a protective plate **308** that is rotatably attached to the axis of drive roller **244**. The protective plate **308** allows blade **270** to be exposed to the paper sheeting as it progresses through the crumpling apparatus. Although protective plate **308** may be attached to any portion of the crumpling apparatus, attaching protective plate **308** to the axis of drive roller **244** provides an expedient way to allow protective plate **308** to move and to thereby expose blade **270** to the paper sheeting. This design may be combined with the other descriptions of the cutting mechanism disclosed herein, such as that shown in FIG. **14**.

The paper crumpling apparatus, as described herein, allows a length of crumpled paper sheeting to eject from the paper crumpling apparatus, to be utilized in packing boxes or other containers having products contained therein, or for any other use apparent to one having ordinary skill in the art.

The present invention has been described above with reference to exemplary embodiments. However, those skilled in the art having read this disclosure will recognize that changes and modifications may be made to the exemplary embodiments without departing from the scope of the present invention.

We claim:

1. An apparatus for converting sheeting material for making a cushioning product, comprising:

a first roller connected to a drive mechanism;

a pinch element disposed adjacent the first roller wherein the sheeting material travels between the first roller and the pinch element, and further wherein the pinch element pushes the sheeting material against the first roller to engage the sheeting material with the first roller; and

a magnet having a magnetic force for holding the pinch element adjacent the first roller, the magnet and pinch element being configured for allowing the pinch element to automatically move away from the first roller to disengage the sheeting material from the first roller when the sheeting material overloads between the first roller and pinch element and creates a force that exceeds a magnetic force of the magnet.

2. The apparatus of claim 1, wherein the first roller and pinch element are associated to engage the sheeting material and convert the sheeting material for making the cushioning product.

3. The apparatus of claim 1, further comprising a handle which assists in moving the pinch element away from the first roller.

4. The apparatus of claim 1, wherein the pinch element is configured for changing the tension applied to the sheeting material as the sheeting material travels between the first roller and the pinch element.

5. The apparatus of claim 1, further comprising a first arm attached to a pivot point wherein the pinch element is attached to the arm, wherein the pinch element is magnetically held adjacent the first roller.

6. The apparatus of claim 5, further comprising a second arm attached to the pivot point wherein the first arm is magnetically held to the second arm for holding the pinch element adjacent the first roller.

7. The apparatus of claim 5, further comprising:

a pivotable door attached to the pivot point and a guide element attached to the pivotable door, the first arm magnetically held to the pivotable door for holding the pinch element adjacent the first roller, wherein the sheeting material traverses under the guide element causing upward pressure on the third roller; and

the pivotable door interconnected with the first arm at the pivot point, wherein upward pressure on the guide element causes tension applied against the first roller by the pinch element to increase.

8. The apparatus of claim 7, wherein the guide element comprises another roller.

9. The apparatus of claim 5, wherein the pinch element comprises a pinch roller.

10. The apparatus of claim 1, further comprising a neck at disposed for feeding the sheeting material to the first roller and pinch element and configured for reducing the lateral width of sheeting material fed to the first roller and pinch element.

11. The apparatus of claim 1, wherein the feeder comprises a guide having a plurality of longitudinally disposed tines for guiding the sheeting material and disposing a wave pattern in the sheeting material, wherein the tines are curved longitudinally.

12. The apparatus of claim 11, wherein the tines are arranged to define an imaginary surface disposed over the tines, over which the sheeting material is directed, that is curved laterally and longitudinally.

13. The apparatus of claim 1, wherein:

the apparatus is a crumpling apparatus configured for crumpling the sheeting material for making the cushioning product; and

the first roller and pinch element are disposed in a crumpling zone configured to crumple the sheeting material, the first roller comprising a drive roller, and the pinch element comprising a pinch roller, the drive roller and pinch roller associated for cooperatively pulling and crumpling the sheeting material.

14. The apparatus of claim 13, further comprising a cutting mechanism configured for cutting the crumpled sheeting material.

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